Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

INTRODUCTION.

The preaching of the gospel of Jesus Christ has been since the days of John the Baptist the most momentous and important of all human occupations. Our Saviour sent him as his herald out into the world to announce his coming. While the Prince of Peace yet lingered in the humble obscurity of his home in Nazareth, the fiery soul of John was startling the echoes of the Judean deserts with his fearful arraignment of a guilty world. God had given mankind the inestimable gift of the Holy Scriptures constituting what we now call the "Old Testament"; but a new agency was then added in the fullness of the times for the regeneration of a race lost in sin. The old dispensation had not repelled the humble searcher after truth. It provided that upon the proselyte's submission to the rite of circumcision, he became to all intents and purposes one of the chosen people, and entitled to all the Jewish national and religious privileges. But the salvation of the Gentiles was a matter of small concern to the holiest of the Pharisees. They seemed, on the contrary, to bitterly resent our Saviour's gracious promise, that in his atonement all the nations should be blest. Their aversion and scorn for the despised Gentiles led them to oppose any scheme of extending the hope of salvation to such worshipers of stocks and stones.

So when, in the mysterious providence of God, the time had come to rend the veil in the temple and to throw wide open the doors of mercy for all mankind, chosen heralds were needed to bear the gracious proclamation to a waiting world. It had been confidently expected through ages of suffering by the Jews, that the Messiah would bring deliverance; and Plato among the Greeks and Virgil for the Romans had told mankind that some revelation from God might be witnessed at any moment. In the sumptuous and inane ceremonies of the heathen temples there had been nothing to educate mind or soul. Even in the grandeur and pomp of the Mosaic ritual there was little beyond the sacred chants and the making of sacrifices to appeal to guilty consciences. Such worshipers as Hannah, and the humble publican who smote upon his breast and prayed God to have mercy on him a sinner,

bath gives his congregation the results of his prayerful and elaborate preparation during the week, is bound to be largely blessed spiritually, and also serves to elevate and chasten the community around. How all-important, then, is it that the Baptists of North Carolina should work and struggle to bring about such a consummation of affairs as would eventuate in each country neighborhood's having a strong, self-sustaining Baptist church, where on every Sunday they can meet and hear the word of God proclaimed in all its truth and simplicity. Wherever in such circumstances an able and godly man gives long years of faithful service to the same people, we find a community blessed with every earthly advantage. They are not only prosperous in worldly matters, but add refinement to wealth, and over and above all things else, their trust and faith in God bring peace and sanctity to every christian household.

In the preached word of God is the world's great hope of ultimate evangelization. The sects and societies that wait on the slow work of self-instruction by means of the Bible and other religious literature generally make but small accessions to their ranks. In the Romish and other Pedobaptist churches the reliance is on infant sprinkling as the means of continuing their existence. They keep up a show of life in this way, but alas! how few are the men and women thus inducted into the churches who really know and care for the religion of the Saviour? To the vast majority of such people the Bible is a sealed book. Their faith consists in the belief that a few empty and unmeaning forms will be sufficient to atone for all their wasted and unprofitable lives, and that the absolution granted on confession to their priests will be sufficient atonement for all their sins. To such people the new birth is all a myth, and the practical observance of the Sabbath a thing unknown.

To Baptists, consequently, their preachers are all important. We consist of churches made up of actual believers who have neither inherited or bought for gold their hopes of heaven. We hold that such views are only consistent with the system devised by our Lord and his Apostles. We are a people separate and apart from all others, and it behooves us to not only cherish and provide for our preachers of to day, but to recall and do reverence to the memories of those who have gone before us. With the hope that something of their virtues and labors may be recalled and preserved, these pages are written. Like "Old Mortality" tenderly

restoring the effaced inscriptions on the tombs of those he had loved and lost, so would we now recall the names and deeds of the brave men who so largely helped to make North Carolina and this great republic what they are. With no desire to unduly magnify the importance of their holy calling, we would yet do justice to men who in sore privation, too often in danger, and always in the face of bitter and unrelenting opposition, found means to plant and nurture our earliest Baptist churches.

They found a land almost God forsaken and given over to the Devil and his agents. The means of grace within reach of our forefathers in the earlier Colonial days, were so utterly wanting or abortive, that in the few exceptions to the general neglect of all religion, for a long time only the Quakers of Perquimans and Pasquotank sustained anything like christian worship. The huge territory stretching more than half way from the Atlantic ocean toward the Mississippi river had not a single organized church other than that just mentioned. How much Paul Palmer and his successors in the Baptist ministry have effected to change the character of our people can only be understood by those conversant with the state of affairs previous to their labors in the land. The brave, true men who were so prompt to resent any foreign invasion upon their rights and liberties were from the beginning eager to bear the story of the cross. They sat, some weeping, and others smoking their pipes, as Fox and Edmunson, the Quaker missionaries, told of the Saviour.

North Carolina early became a city of refuge to the persecuted Baptists of other provinces. While members of the established church were always contemptuous and bitter in their opposition in those early days, yet under the law they could find no pretext for actual persecution save in the very statute which was intended to prevent all violence and individual oppression. With a strange mockery of all propriety, the sticklers for conformity would swear out peace warrants against Baptist missionaries, in which, with all the solemnity of an oath, they deposed that these humble men of God were disturbers of the public peace. That preaching Christ and him crucified led to violence, and therefore compliant magistrates too often became [illegible] of such a mockery of justice and required the preacher to give bond for his good behavior and peaceful conduct toward the people. Some smilingly complied with the wretched pro-

vision of all law and justice and gave bond as required, but others were made of sterner stuff. These told the magistrates they had violated no law, human or divine, and that they would cheerfully abide in jail as long as their worships saw fit to limit. Such men, like John Bunyan, made their prisons lively with hymns of praise and sermons delivered through the windows.

It was thus amid much tribulation that the pioneer Baptist preachers of America made good a lodgment for their faith in the domain which was ere long to burgeon out into the world's most imperial republic. Often despised and neglected by the people they came to bless and save, they had the grace still to persevere in the good work. As the years went by, they saw the horizon of their hopes ever broadening and growing more luminous to the eyes of Hope. God was preparing for them greater things than the boldest had dreamed of. Not only was the time close at hand when all their pains and penalties should be swept from the statute books; they were not only to rejoice in the fulness of that religious liberty which they had advocated and prayed for so long; they were also to suggest and establish, by means of their example, the controlling features of the American civil polity. Baptist freedom and democracy became the prototypes and models by which was constructed the mighty fabric of the United States. And thus once more the stone rejected by the builders became the head of the corner.

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The theory, which is now almost universally admitted, as best explaining the phenomena in question, though suggested by the hints furnished by preceding discoveries, was first reduced to a systematic and consistent form by Lavoisier. The metals, accord-

* Annales de Chimie, lxix. 92.

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Memoir I—Paul Palmer.

CHAPTER FIRST.

A little more than two centuries have elapsed since the first permanent settlements were effected by Englishmen in North Carolina. Such a period in human history seems very short at best, but it has been long enough to bury in oblivion a multitude of men and facts we would gladly preserve and transmit to coming ages. The men and women who, in the middle of the seventeenth century sought homes and refuge in Albemarle, came under different auspices from all the other plantations in America. Not even that famous band of pilgrims, that made Plymouth Rock so conspicuous in human annals, afforded much analogy to the early scenes enacted in Carolina. No king or governor was consulted for permission to enter the paradise Amadas and Hariot had so eloquently described. Many thousands had left their homes in Great Britain and the continent of Europe with the hope and expectation of enjoying complete religious liberty in America. Such immigrants as a general rule landed in Boston and Jamestown. At both places they found a stern and jealous inquisition as to their religious opinions. When the new citizen agreed with Puritanism in Massachusetts and the Thirty-Nine Articles in Virginia, all was well, and such an immigrant was received with open arms. But if it so happened that neither Puritanism or Episcopacy claimed him for its own, then alas for the unhappy dupe who had as it were jumped from the frying pan into the fire. Charles II. and his bigoted successor made life hard enough for the Baptists, but Gov. Berkeley surpassed even these persecutors in the sternness of his policy. The poor deluded victim of false hopes was at once told to leave Virginia and that with all possible speed. To avoid severe punishments, the exiles moved on to the unknown wilderness and sought amid the heathen Indians a refuge his christian countrymen had refused. Like Roger Williams expelled from Massachusetts in the midst of a New England winter's direst hardships, so fled the

men and women who first began the work of making North Carolina a home for civilized people.

How many of these Baptist people, who thus came to Albemarle before King Charles II. granted away the territory thus settled, is not now known. Rev. Dr. W. H. Whitsitt, in his able and suggestive sermon delivered in June, 1888, at Wake Forest College, gave some very valuable hints as to this matter. He quoted the Rev. Morgan Edwards as to his declaration that as early as 1695 there were individual Baptists in the colony. Richard Knight, another historian, affirmed that they were to be found there five years earlier. He then argues from the liberality of North Carolina government as to religious toleration that nothing prevented these Baptists from forming churches. The declaration of Rev. Lemuel Burkitt, in his history of the Kehukee Association, that Paul Palmer was the founder of the first Baptist church in the Province, and that Shiloh, this church, was formed in 1727, has been long taken as definite and conclusive on the subject. But many things support Dr. Whitsitt in his belief that Baptist churches were in existence even before then. The following extract from a letter written by Rev. Mr. Blair, a missionary sent out by the Bishop of London and the English Society for Propagating the Gospel in Foreign Parts, shows conclusively that as early as in 1704 Baptist evangelists were traversing Albemarle and baptizing their converts. Mr. Blair says, in speaking of the religious sects then to be found in the colony:

"A third sort are something like the Presbyterians, which sort is upheld by some idle fellows who have left their lawful employment, and preach and baptize through the country, without any manner of orders from any sect or pretended church."

This was in strict keeping with the usual Episcopal scorn and ignorance touching the Baptist people. This Mr. Blair pretends that he does not even know the name and classification of the creed which was winning converts and establishing itself in a region where ere long it was to number nine-tenths of the people in its fold. Of course, these unknown missionaries of 1704 were Baptists, and surely if they were baptizing men and women, they were also planting churches as they went. But these churches were composed of a people very unlettered and humble in the social scale. Their records, if they kept any, have been all lost, and thus it is that we have by John

Comer's Journal of a trip through Carolina in 1727 the authentic assurance that a church of the Baptist faith and order was at that date in existence, with Rev. Paul Palmer as its pastor. Like Dr. Whitsitt, we are fully persuaded that various other Baptist churches were then to be found in North Carolina, but they were so disunited and widely separated that no effort was made to preserve memorials of their existence. We know too that before the reformation wrought in the latter part of the eighteenth century that much latitude was allowed in the creed and practices of those Americans who called themselves Baptists. The open communion sentiments of John Bunyan and those of his school had their legitimate results in opening the church doors to members who made no profession of religion. The famous prophecy of the great merchant and preacher, William Kiffen, in his reply to his Brother John Bunyan that the disregard of Bible baptism as requisite to participation in the Lord's Supper would eventuate in a disregard for all the ordinances, had long been verified in the Quakers. The alliance between the Quakers and Baptists had been very close in Albemarle, and no doubt a portion of their disregard for both of our church ordinances had been largely infused in the sentiments of their compatriots. Although the English and Dutch Baptist churches had found great benefits arising to the individual congregations from their joining in the formation of associations, the American churches had long foreborne to follow such salutary example. The old Baptist love of independence in each separate church, and the fear that such an alliance might eventuate in impairing this autonomy, had kept them struggling in separate orbits and largely inefficient and helpless from their total want of sympathy and co-operation. The best and strongest of the city churches might support its pastor and do much toward the feeding and clothing of their own pauper members, but beyond this their christian charity had no extent. Some might aid a deserving young brother in his preparation for the ministry, but such cases were like angels' visits.

But let us of the present day thank God that a season of better things was at last to dawn on the world. Twelve churches in and around the city of Philadelphia sent up delegates A. D. 1706 and formed the first American Baptist Association. With this formation of the Philadelphia Association,

there came as it were a new lease of life and power to the Baptist communities thus united in the bonds of love and duty. The old fear and distrust of men as to each other's good faith had nurtured and sustained all the tyrranies both temporal and ecclesiastical which had cursed mankind with their misrule. It was a common belief that the people were incapable of self-control, and therefore kings and nobles should hold them in subjection. The Baptists followed the Bible and the early christians in keeping up the people's control of their own church, but they feared the possible action of sister congregations in case a league was formed for the execution of some common purposes. The results of the Philadelphia coalition were so speedily seen to be good and useful, that many wise men in other sections wished their churches to do likewise, but the old Baptist conservatism wisely waited and watched to see how time would tell on the new experiment.

Among the churches which constituted this same Philadelphia Association, was one situated in the Welsh Tract of the Province of Delaware. This congregation had long been recognized for its intelligence and devotion to all good works. Hearing of the loose and disorganized coudition of Baptist affairs in North Carolina, they sent out Rev. Paul Palmer as a missionary some time about 1720. These missions of love and mercy were common in those early days of the American Baptist Association. We find that not only were able divines sent out as aids and advisers of the scattered congregations in the white settlements, but the Indians also came in for their share in these early manifestations of christian zeal and benevolence. Mr. Palmer was a native of Maryland, but was baptized into Baptist fellowship by Rev. Thomas Owens, then pastor of the Welsh Tract congregation. He was ordained to the full work of the ministry in Connecticut. After service in the churches of New Jersey and Maryland, he came to North Carolina. His home for the subsequent years of his life was in Perquimans county. There on the beautiful shores of Albemarle Sound he began and ended his labors as an evangelist among our plain and unassuming forefathers. He found the harvest ready for the sickle. A people brave and patient had after many struggles and some bloody disorders triumphed in their efforts for some show of freedom and autonomy. Wily and insidious British agents had long perplexed them with schemes of interference in their religion and trade. The English governors and their coadjutors in the General Assembly were struggling for

the erection of a State church, and from London came continuous orders for the enforcement of the navigation laws. But these wise men of old wanted neither a religious establishment nor any such restraints on their commerce. Mr. Palmer found them in comparative freedom from both of these sources of former strife and discontent. With his young wife thus far removed from the scenes and friendships of former years, he began his life-work in North Carolina.

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The same metal, also, is, in some instances, susceptible of uniting with different quantities of sulphur, and of affording compounds characterised by a different set of properties. Thus the compound, which consists of $62\frac{1}{2}$ iron and $37\frac{1}{2}$ sulphur is of a dark grey colour; has little or no lustre; is magnetic; and easily broken. But 53 parts of iron combined with 47 of sulphur form a compact substance, of sufficient hardness to strike fire with steel, and having so much lustre as to have been often mistaken by the ignorant for gold.

Metallic sulphurets can only be partially decomposed by heat; and though this assertion appears to be contradicted by the effect of roasting these compounds, yet it is to be considered that the metals, when heated with the contact of air, absorb oxygen, and thus lose their affinity for sulphur. The sulphuret of one metal may, in many instances, be decomposed by another metal. Thus when sulphuret of mercury is distilled with a proper proportion of iron filings, the sulphur passes to the iron, and the mercury comes over in a metallic state.

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* Berthollet, *Annales de Chimie*, xxv. 256.

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MEMOIR I—PAUL PALMER.

CHAPTER TWO.

When the Rev. Paul Palmer came to Albemarle, he found as his neighbor in the town of Edenton one George Burrington, who was then Governor of the Province of North Carolina. This turbulent and erratic spirit exhibited in himself the weakness and folly of the men who, as Lords Proprietors, claimed and exercised rule over the colony. Mr. Burrington's infirmities of soul could not have been unknown to the Lords and gentlemen, who gave him his commission, for he had been convicted and punished in the London criminal courts for the offence beating an old woman. His shifty and violent temper, combined with a ruthless disregard of the rights and feelings of others kept him in trouble all his life and finally led to a violent death. Yet such a man was selected, of all the able and capable subjects of Queen Anne, for the delicate and difficult duty of restoring order to a community just emerged from the double horrors of civil war and Indian massacres. But Paul Palmer and the good people of his adopted home were soon to be delivered from the weakness and avarice of the Proprietary Government. In 1728 the Crown bought out all the rights of the Proprietors save those of Lord Granville, and North Carolina was no longer the prey and victim of individual greed and rapacity.

As we have already intimated, much of the information, now accessible touching the labors of Paul Palmer in North Carolina, is derived from the journal of John Comer. This Baptist evangelist traversed the Province in the year 1727 and met the subject of this memoir personally. In the brevity of his itineracy, we have only short notes as to the various points visited and no attempt at detailed narrative, either touching the history of the past or the general condition of the churches in that period. It was through the publication of these notes of travel that we can now safely affirm that Mr. Palmer had succeeded so far as to establish a permanent church known as Shiloh. This ancient and revered christian

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Dr. David Benedict, in his Baptist History, intimates that Paul Palmer got into some trouble which militated against his usefulness as a minister of the gospel, but he does not specify what this trouble was. This was a source of grief to the author of these sketches until, in his researches in the lately published Colonial Records, a discovery was made as to the nature of Mr. Palmer's offence. It seems from the old court records of Perquimans county that in the year 1720, he and his wife Joanna were indicted for aiding in the rescue of a negro prisoner from the custody of the officer who held him under arrest. It must have been simply an ebullition of misplaced pity and sympathy for one in distress, for the record shows that David Richardson, then Attorney General, refused to prosecute the case, and the defendants were dismissed from court without even so much as paying the cost.

While the foregoing circumstance would indicate a rash and impulsive nature, it by no means involves any degree of moral turpitude beyond Mr. Palmer's failure to remember the oft-repeated injunction of our Lord for his servants to obey the powers that be. This constable, however humble a representative, still embodied in himself the majesty and sanctity of the law. Though the preacher and his wife might be sure of the falsehood and injustice of the charge against their African neighbor, still they were wrong in their choice of a remedy. It is far better to endure oppression than inaugurate rebellion, while there yet remains a hope or possibility of rectifying the evils inflicted. It was ill-advised, too, because Mr. Palmer might be sure that the enemies of his faith would never stop to explain the extenuating circumstances, when in triumph they told how the Baptist missionary had been indicted as a public malefactor. But with all these suggestions of worldly wisdom, he could still enjoy the high satisfaction of knowing that his sufferings were the result of no selfish promptings. If he was numbered among malefactors, his Lord and Master had undergone the same ignominy.

In his choice of a field wherein to labor for the Lord, Mr. Palmer found a host of men, who would view his advocacy of Baptist faith and practices with anything but favor. Perquimans was the very center and

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nucleus of both Episcopal and Quaker influences. The strongest congregations of both these sects were to be found where he began his work of evangelization. The strongest imagination would fail in its endeavor to depict the scorn and surprise of the one party, and the cool indifference of the other. The men of the Established Church were too much under the control of Edward Moseley to offer any show of real persecution; for that patriot and statesman, while warmly adhering to the dogmas of his church, was still ever the advocate of religious freedom. He was too powerful both in the General Assembly and Church councils, for any open infringement of the spirit of the charters; so all the vexation of the people of his faith expended itself in petty schemes to abuse the unwelcome intruder in the public mind.

The people of Albemarle had been too often disgusted with the Established clergymen, for any real attachment to have been formed toward them and the faith they represented. Some of these English preachers, as the Rev. John Urmstone and others, not only neglected the sacred duties they were sent from across the seas to fulfill, but also led shameless and immoral lives. Urmstone was notorious for his many vices. He was repeatedly arrested in the streets of Edenton and punished by the court for his drunkenness and profanity. That such a man could be permitted for long years to receive the bounty of benevolent Englishmen, shows to what a low ebb the morals of the people in both hemispheres had descended. A candid statement of affairs requires that such disagreeable truths should be made known, but it must not be once imagined that there were no real and devoted christians in the Episcopal clergy. There were many who would have died to maintain the integrity of the Protestant faith, but the fatal effects of the restored Stuart dynasty on the public morals had not yet been succeeded by wiser and better courses.

It was thus that Paul Palmer and his coadjutors found the people willing and eager to receive the messengers who came with promise of better things. Taking 1725 as the year of the first real Baptist evangel in North Carolina, it seems almost incredible how fast their influence spread over the Province. Among Mr. Palmer's earliest converts was the Rev. Joseph Parker. He was the main stay and support of the Evan-

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gelist, and together the greater portion of eastern Carolina and southeastern Virginia. The second church organized under their labors was at a point in Bertie but now Hertford county, just outside the future village of Murfreesboro. This was long known as Parker's Meeting House, in compliment to Mr. Parker, its first pastor. He removed from Pasquotank and dwelt the remainder of his life on the farm just in the rear of the Chowan Baptist Female Institute. Joseph Parker was never a bri liant orator, nor was he very wide in the range of his acquirements. His chief trait was his indomitable adherence to whatever opinion he first adopted. He could never be persuaded to take part in Association or Convention, and so long as he and his son, Rev. William Parker, lived, they kept by their influence the Meherrin congregation in the same attitude. Although every other Baptist church in the commonwealth had joined the Sandy Creek or Kehukee Association, these men of iron wills still, with their single church. stood aloof and would take no part in the great work that Burkitt and his colaborers were, with God's help, carrying on. It is a singular coincidence that after the lapse of a century and a half we see Rev. Hersey B. Parker, who is the direct descendent, five degrees removed from this ancient worthy, reviving in our day the very same crudities and mistakes.

Paul Palmer lived long enough to see a great advancement effected both in religious and political affairs under the wise and gentle rule of Gov. Gabriel Johnston. A mighty host of settlers came pouring in from every direction, and North Carolina in a few years had a population four fold greater than when the Scotch ruler arrived. The Baptists had made a start in their great work of evangelizing this and other American Provinces, and from thence onward their career has been unbroken. Though men would yet shudder as they recalled the horrors of the Tuscarora massacre in 1711, still the Lord's work of saving the souls of those who had committed the bloody crime, must be at least attempted. The hardy settlers kept pushing on in the wilderness towards the setting sun. To such people also the gospel must be preached. This matter of planting and sustaining churches in the Colony had been a source of continual struggle and content ever since the time when Col. Daniel as Governor of Albemarle had induced the General Assembly to pass the law

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known as the "Vestry Act." The people had been promised repeatedly by King Charles II. and the Lords Proprietors that if they would come to America they should have in Carolina the fullest religious liberty.

This Vestry Act was directly in opposition to such a promise. It provided peremptorily that every parish should elect twelve Vestrymen whose duty it should be to raise by taxation out of all the people money with which to build an Episcopal chapel, and then to levy $150.00 more each year as a salary for a rector of the same faith and order.

The Baptists and Quakers said, with truth and justice, that the building of such a chapel and the salary of such a rector were no concerns of theirs. They had a church of their own and a pastor of their own to support. Let the Episcopal people build their own house and pay their own rectors. That it was an outrage to thus pillage men of their hard earnings to sustain others who were too often viler than the heathen Africans they essayed to convert and baptize. The law proved abortive in most of the counties by the dissenters choosing men of their own creeds as Vestrymen. Of course, these would make no levies for church building, nor would they employ a rector.

To such men the coming of Mr. Palmer was as a most grateful dispensation of Providence. They heard the story of our Lord's passion with streaming eyes and hundreds were added to the Baptist fold. The new county of Bertie, which included all the North Carolina territory between the Roanoke and Chowan rivers, became a center of influence from which missionaries proceeded to evangelize the more remote settlements. By-and-by the Episcopal chapels of St. John and St. Luke in Manney's Neck found themselves almost deserted. The handy men and women, who were peopling a wilderness, instinctively turned to the faith and forms that centuries before had won the hearts of the Galilean shepherds and fishermen. How long the man lived, who had thus come from afar to labor in a field of which he knew nothing, is now forgotten. But his name is yet fresh in our memories, and the labors he endured still bear their fruits in the region where two such great christian organizations as the Chowan and West Chowan Associations number their adherents by the myriad. The lights still burn brightly on the altars he

erected so long ago, and a great people delight in doing honor to the name and memory of Paul Palmer. He served the Master in his day and generation, and is now enjoying "that rest which remaineth to the people of God."

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with cold wat d, and
the salt is rendered much more insoluble.

When the super-sulphate is heated for some time, at a temperature exceeding that of boiling water, it loses still more acid, and is changed into a hard grey mass. When this is removed from the fire, and boiling water poured upon it, a lemon yellow coloured powder is formed called *Turbith Mineral.* This substance requires for solution 2000 parts of water. One hundred parts consist of 10 sulphuric acid, 76 mercury, 11 oxygen, and 3 water.

VI. The nitric acid dissolves mercury, both with and without the assistance of heat. At the common temperature, but little nitrous gas is evolved by the action of mercury on nitric acid; and the acid becomes slowly saturated. The solution is very ponderous and colourless; and yields, by evaporation, large transparent crystals. The solution does not become milky when mingled with water. Pure fixed alkalis give a yellowish white precipitate; and ammonia a greyish black one.

But if heat be used, a brisk effervescence arises, occasioned by the escape of nitrous gas, and a solution is obtained, in which the metal is more highly oxidated, and the acid is in less proportion. When this solution is poured into cold water, a yellowish white sediment is formed; or, if into boiling water, an orange coloured one. Both precipitates consist of nitric acid, with a great excess of oxide, forming an insoluble *sub-nitrate of mercury.*

If the last mentioned solution be boiled with a fresh quantity of mercury, the newly added metal is taken up, without any discharge of nitrous gas, the metal becoming oxidized at the expense of that already dissolved.

When the nitrate of mercury is exposed to a heat gradually raised to 600° or upwards, it is deprived of water and of most of its acid, and reduced to an oxide, which has the form of brilliant red scales. This substance, commonly called *red precipitate*, is termed more properly the *nitrous oxide of mercury.*

VII. Mercury is the basis of a new fulminating compound discovered by Mr. E. Howard. To prepare this powder, 100 grains (or a greater proportional quantity not exceeding 500) are to be dissolved, with heat, in a measured ounce and half of nitric acid. The solution being poured cold upon two measured ounces of alcohol, previously introduced into any convenient glass vessel, a

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

MEMOIR II—REV. WILLIAM SOJOURNER.

CHAPTER ONE.

The first permanent English settlement in America was at Jamestown in Virginia. There in the year of our Lord 1607, John Smith and his comrades rocked the cradle of our new imperial republic. This colony on James river was in many respects unlike all the others, that later on formed the American Union. It was from its earliest inception a pet of the Crown and the British nobility. To its borders came hundreds of young people who belonged to the proudest families in England. It was thus from the beginning under the dominion and influence of the English Established Church. Hard-riding, deep-drinking, loud-swearing country squires, who really cared very little for Christ as their mediator, were yet devoted Churchmen. Utterly empty of faith, hope and charity, they were yet ever ready and willing to cut the throats of others who failed to conform to the ritual and canons of the English Church. Such men formed a large majority of the Colonial Legislature. It can be easily imagined what a cruel and inexcusable system of laws such men would enact. Their treatment of the Quakers would have disgraced the Turks. When a stranger came in their midst, the law required that the rector of the parish, or some other public officer, should see such person and inquire of him as to the nature of his religious opinions. If it appeared that he conformed to the Thirty-nine Articles, or was a Presbyterian in good standing, he was allowed to remain and find a home in the Colony of Virginia. But wo unto all others! If they came by way of the seas, the captain of the ship bringing over such malignants was required to carry them back to the port from which they sailed. In cases such as those, where men and women came southward from settlements of Maryland and Pennsylvania, they were forthwith expelled from the borders of the Old Dominion, with fearful penalties as the price of their return. A few French Huguenots, under the express orders of the Crown, were left unmolested, for many of them became members of the Episcopal congregations.

In the lapse of time this fierce and rigid exclusion of Baptists and Quakers was relaxed from the fact that such people were too wise and self respecting to seek homes in such a community. Rhode Island, New Jersey, Pennsylvania, Maryland, both the Carolinas and Georgia were ready and willing to give homes and fellowship to all who in good faith came in their midst. To these Colonies flocked the persecuted Dissenters, and Virginia was left to enjoy for a season all the honor and glory due such faithful and discreet sons of the Church. Lord, had they not cast out in thy name all these vile and deluded schismatics? Were they not secure from these insidious agents of sin and heresy? Alas, no! However cruel their statutes, Baptists of other communities resolved at length to risk life and all things temporal in their efforts to redeem a noble people from such mistakes in religion and policy. We are told by Rev. Dr. R. B. Semple in his history of the Virginia Baptists, that when the first of their evangelists began to labor in Virginia the State and Church authorities had them in such utter contempt that they said it was useless to notice these men. That they were so weak and obscure that no possible harm could arise from the people's hearing what such fanatics had to say. It was after these humble Baptist evangelists had won the hearts of hundreds of the people for the Master, that the strong arm of ecclesiastic wrath was invoked. How long and nobly those Virginia Baptists wrought and suffered is one of the world's most heroic epics. They were the loving allies and friends of Thomas Jefferson, Patrick Henry and of James Madison in all their great and protracted labors in securing religious liberty for their State and nation.

At the very beginning of these Virginia church troubles the subject of this memoir, the Rev. William Sojourner, along with many of his flock, came to North Carolina for refuge. All the old records and traditions speak well of Mr. Sojourner. It sounds almost like a romance to recall the facts connected with him and his church at Burley in Isle of Wight county. As early as 1714 the Burley congregation, being destitute of a pastor, wrote such letters to the Baptists of London, that two men, Robert Nordin and Thomas White, were ordained and sent out to aid these American petitioners. The two young men thus departing on the long and perilous journey of that era, no doubt felt many a swelling joy in their souls over their consciousness of giving up home and all its comforts to serve the Lord. Before

the long and weary days had gone by which were consumed in sailing from London to James river, Thomas White sickened and died. It was a dark and mysterious providence, and Robert Nordin, no doubt, grieved long and sore over the death of his companion. But the sailors wrapped the cold form of the dead missionary in a hammock and thus gave him burial in the depths of the ocean.

It seems that Robert Nordin preached unmolested and with much success until his death Dec. 1st, 1725. On the 30th day of April, 1727, Richard Jones was ordained and chosen as pastor to this same Burley congregation. But the establishment of the Baptist church in Prince George county and the active evangelism of Rev. Casper Mintz, along with pastor Jones, stirred up wrath in the high places. The Episcopal parsons and their lay strikers said these Baptists were stirring up the world with their harangues and were thus liable to be punished at law as disturbers of the public peace. Magistrates who would hear a simple sermon of loving exhortation to perishing sinners—breathing peace and forgiveness of injuries in all its extent would then see brutal ruffians interrupt such a discourse by a shower of rotten eggs, would see these same men beat and almost drown the inoffensive man of God. Such a magistrate neither sought to restrain the assailants, or to punish them afterwards, but in sublime mockery of all humau justice, would send his sheriff or constable with orders to arrest the injured preacher as a public nuisance and disturber of the peace. Some of the meek and gentle brethren would so far comply with these miserable Dogberry justices as to give bond for their keeping the peace. But others were made of sterner stuff. They told their wicked judges that they had violated neither the public law nor the public peace, and would therefore give no boud but rot in their jails before their giviug countenance to a miserable perversion of law and justice.

Many of them made good all such brave utterances. Like Paul and Silas, they for long months aud weeks made the old jail houses musical with their hymns of praise. Great crowds of indignant and sympathetic people gathered and were preached to from the grated windows of the prison. It seemed as if the gospel was never so powerful as when God's servants were thus bearing witness amid danger and suffering on his account. Many hundreds professed to have found peace as they thus stood and heard the gospel proclaimed from the windows of the jail.

But all were not made of such stern stuff as to really enjoy the privilege of bearing such testimony to the truth. The Rev. William Sojourner had succeeded Mr. Jones in the pastorate of Burley. He and a large proportion of the congregation grew weary of the struggle and contention, and resolved to leave their homes for the peace and quietude of North Carolina. Edgecombe was then a new country. On Kehukee creek in the latter bailiwick, Mr. Sojourner and his colony halted, and there established the famous old Kehukee church. This region in that era was very different in its aspects from the county, Isle of Wight, where their old homes were. All the region bordering on James river was in that age thickly settled and possessed of many social appliances. Mr. Sojourner and the little flock he led found the late hunting grounds of the Tuscarora Indians covered by a vast unbroken forest. A few families had congregated at and around the village of Enfield where the court-house for Edgecombe county was located, but in 1740 the region selected as the future residence of these christian refugees was still in its primeval condition. About thirty miles southward was the spot on Contentnea creek whereon was built the famous Indian fortress which was stormed and captured during the late war. As all the hostile Tuscaroras had left North Carolina and found new homes in the lake country of New York, Mr. Sojourner and his colonists had only a few stragglers of that bloody tribe to fear in their new homes. True, it was that occasionally a solitary man or woman was found murdered and scalped by these vengeful spirits, but Thomas Blount, the friendly chief, who still lingered in Bertie by degrees captured and slew the last of these murderous vagrants. Rev. Joseph Parker and his coadjutor, Mr. Wingfield, had no doubt been heard at Enfield and elsewhere in Edgecombe proclaiming the truth as held by the American Baptists, but no church had been established nearer than Sandy Run in Bertie. This church by a strange coincidence came into existence in the same year that saw the advent of Mr. Sojourner and his people. It was not a great distance thus across the Roanoke river between a regular Baptist chureh and the Virginia colonists in Edgecombe. There was, no doubt much social intercourse between the old and new Baptist denisons of that fertile region, for no bridges were built across

great river separating them, still there ere numerous ferries.

The Rev. William Sojourner found a formidable obstacle to the spread of his Baptist views in the person of the Rev. Charles Burgess. This latter was a clergyman of the Episcopal church and was only equalled in all the catalogue of his brethren of the cloth by Rev. Charles Earle of Chowan. Both of these wise and godly men were greatly admired and trusted by the people, and their influence was widespread and ever for good in the land. The very fact that Messrs. Earle and Burgess were so different from the generality of those who had come as Episcopal missionaries gave a greater interest with the people. It had not been expected after their experience with Mr. Urmstone and others of his kind, that any Church of England clergyman really cared for the souls and salvation of their flocks; but here were men whose piety and rectitude no man could doubt. It was thus hard work for Mr. Sojourner to hold his own with such a rival close by at Enfield. There has ever been a love of pomp and spectacle in the mind of man. This has given the Romanists their greatest hold upon the people. So, too, with their daughter of England. She has retained just enough of the shows and vestments to avoid offending good taste. The Church, too, has ever been in America a great aid to people whose great desire is to rise in social consideration. We constantly hear the worldly-minded making sneering remarks as to the want of refinement in the Baptist and Methodist churches. They are like that proud scribe of old who asked if any of the Pharisees had as yet believed on Jesus Christ. We hear these his modern imitators often testifying their devotion to their church, but alas the name of him who died in such unspeakable agony on Calvary is rarely on their lips. That phantom they call "The Church" absorbs all the love and enthusiasm of such believers, while the Virgin Mother and Mother Church serve a like purpose with the Romanists. What is such folly but cheating God of the devotion we owe to him? What is the church worth to any man or woman beyond affording him a means of testifying faith in the lamb of God who taketh away the sins of the world? The churches are, no doubt, great instruments of grace and help us on in our efforts to do what is right, but let us never forget that after all they are only congregations of weak and erring mortals. They are God's means of converting the world and keeping in everlasting remembrance the Great Shepherd and Bishop of our souls.

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

MEMOIR II—REV. WILLIAM SOJOURNER.

CHAPTER TWO.

In looking back through the long vista of years which have elapsed since the Rev. William Sojourner lived and labored on earth, we are struck with astonishment that so many of the most enduring elements of our faith and polity originated in the time of his stay in the commonwealth, North Carolina, at that period, was in that plastic condition which is most favorable for the reception of religious and political truths. In the gross and inexcusable neglect of their duties, both by the Lords Proprietors and afterwards the Crown, the people had been left almost entirely to their own devices in religious matters. It seemed that of all the host of preachers of the English ecclesiastical establishment, only a few men, who could find no employment at home, ventured over as guides to heavenly places. The people were quick to see that most of these men needed reformation of life as much as they did. It was only about this very year of 1740, which saw the advent of the Burley colony, that Gov. Gabriel Johnston and Mr. Edward Moseley succeeded in obtaining real religious guides. The Bishop of London, who claimed North Carolina as a portion of his see, at last sent over the Rev. Charles Earle to serve the churches of Edenton and Perquimans. Bertie, then the most populous county in the Province, was supplied with a rector in the person of the Rev. John Alexander, while Edgecombe rejoiced in the presence and services of the Rev. Mr. Burgess. All of these gentlemen were highly acceptable and useful in their labors; but in Mr. Earle there was a culmination of social and christian graces. He added piety and zeal to his eloquence in the pulpit. He also gave such an example in his daily walk among his people, that all could see how much he was concerned for their souls. All three of these ancient divines lived and died at their posts, and left issue as mementoes of their virtues. Such men of course gave a great impetus to the lagging fortunes of Episcopacy in North Carolina. They did much to atone for the sins of their wicked predecessors, and had all their successors in 1775 possessed the same wisdom and influence, their church would have escaped its shipwreck and prostration.

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Mr. Sojourner heard also of the arrival, at Salem, of the first instalment of the German sect styled by themselves "The United Brethren." These Moravians were in many respects the counterparts of the English Quakers. Count Zinzendorf, eight years before, had begun his wonderful system of missions. Lay brothers, who labored daily for their own food and clothing, were sent out in many foreign parts to bear to other peoples the gospel that had wrought so great a change in their own hearts. They, too, were soon to establish themselves at Salem, and add another feature to the ecclesiastical kaleidoscope of the age.

The Rev. George Whitfield and also the two Wesleys were stirring the British people into a wondrous enthusiasm with their new Methodist societies. Ever and anon echoes came from New England repeating the story of how the Rev. Jonathan Edwards was animating the dry bones of Congregational coldness and apathy. The long-enduring and widespread religious blight which had come upon all English-speaking people as the result of the wicked rule of the two last Stuart kings, was at last yielding to the influences of a livelier faith. The Baptist preachers had never intermitted their work of exhortation for a higher standard of devotion, and at last God was answering their prayers.

Only twenty years had elapsed since Paul Palmer had come in Albemarle, when Mr. Sojourner and his little band of Burley exiles arrived on the banks of Roanoke river, but a great work had been accomplished in that short interval. The cluster of churches, soon to join in forming the Kehukee Association, were organized and at work extending the bounds of Baptist influence.

Many people have expressed astonishment that the Established Church of the Province so soon succumbed in the struggle for supremacy; but no student of English history need wonder over such a fact. It was, as the Right Honorable Joseph Chamberlin, the famous M. P. for Manchester, lately declared, the people knew that ever since the days of King Henry VIII., this State Church had been found on all occasions the enemy of popular liberty and privilege. All the great franchises extorted from the Crown had been won with the bishops and clergy in solid array against such movements. And the church, says Joseph Hume, is to day what it was in the times of Hampden and Pym. In every great struggle, when the

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British Parliament has been called upon to widen the influence and power of the people, the spiritual Lords have been ever found opposing such boon and aiding selfish monarchs in their efforts to resist the demands of the House of Commons.

Then, too, the habits and bearing of the Established clergy had raised barriers between them and the great body of the population. The sons of wealthy and titled families were generally educated with the view of their assuming holy orders long before any evidence was afforded that even piety was theirs, much less the experience of an actual call to preach the gospel. It seemed like mockery to hear such a candidate avow at his ordination that he felt assured that God had called him to fulfill such duties, and yet was ready to mock at the mere mention of the new birth in Christ. Hundreds of such youths were supplied with curacies and rectories by the bare dictum of some rich landlord who mocked at and despised the very name of religion. The English papers of this same week in October, 1891, tell us that the Marquis of Aylesbury holds eleven such presentations while the still more notorious Lord Lonsdale had no less than forty-two. At the bidding of these two wicked and worldly aristocrats, thousands of christian people are thus forced to receive the men who are to minister to them in holy things.

Such were some of the many causes of the amazing success of the pioneer Baptist preachers in North Carolina and her sister Provinces. Congregations were formed in the short interval of time already mentioned from Currituck as far west as Johnston county, and all of them were the fruits of missions sent out from Shiloh, Meherrin, Sandy Run and Kehukee churches. In all the region south and west of Roanoke river, the Rev. William Sojourner was the leading spirit in this great work of evangelizing a destitute and forsaken people.

The disastrous battle of Culloden, fought on the moors of Scotland in the year of our Lord 1745, led to a great emigration from the highlands of that country. The gentle heroine, Flora McDonald, and thousands of her compatriots, found homes along the upper ranches of the Cape Fear river. The nucleus of this settlement, now known as Fayetteville, was called Cross Creek in that day. It does not appear that the Baptist missionaries effected much among them until a much later period in our history. Neither Mr. Sojourner, nor any of his cler-

ical coadjutors, could speak the Gallic tongue; so the Scotch settlements failed to participate in the great evangel of the period.

Just west of the Baptist congregations of Johnston county began the settlements of the Scotch-Irish Presbyterians. These brave, thrifty and devoted christians were so well supplied with preachers of their own, that missionaries rather sought out the waste and destitute regions. They were not so anxious to proselyte their brethren of other persuasions as they were to carry the word to those settling in the "region and shadow of death." Indeed, all that we know of Mr. Sojourner's traits as a man and a christian goes to show the amiability and delicacy of his sensibilities. Sooner than contend with the bigoted and intolerant Churchmen in Virginia, he had shaken the dust from his feet as testimony against them, and came for peace to North Carolina. He was not a man for controversies of any kind. However devoted he may have been in his adhesion to Baptist sentiments, yet he never grew restless or unhappy when he realized how many men and women were ignorant of, or scoffers at, the truth of such a faith. His charity was boundless and unfailing. He no more limited God's saving grace to the narrow confines of his own sect, than to some race charm out from all nations.

Mr. Sojourner was enough blessed of God to be permitted to see the wide diffusion of the truth as he held it while still alive in the flesh. He saw and heard of new churches continually being added to those already in existence, but like Moses on Pisgah, he was denied the privilege of seeing them join a holy league for purposes offensive and defensive in carrying on the great war against the Devil and his agents. The Baptist churches of North Carolina had not yet obtained the consent of their minds and souls for concerted action. Philadelphia and Charleston had seen great things accomplished by means of the Baptist Associations bearing their names. Their missionaries were earnestly persuading our people to surrender this ignoble and unworthy distrust of God's people, evinced by such fears of their good faith. Surely churches acknowledged and confessed to be independent could always have the right of withdrawing from such such a league if it transgressed its charter. How, then, could there arise any danger to the autonomy or integrity of even the weakest congregation? On

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the other hand, what a world of benefits could be expected from the close companionship and community of interests implied in such an organization. Such men as the Rev. Joseph Parker might still adhere to the old order of things, but no such disposition marked the course of William Sojourner. He was ever foremost in all good works and made himself a monument in the hearts of his brethren; but when in A. D. 1765 the Baptist clans at last gathered at old Kehukee to form the long-wished for Association, the Rev. William Sojourner was only there in spirit. The good man for some time had rested in his narrow grave, and nothing but the memory of his great services remained to cheer and animate his people. He had fought a good fight and died more than a conqueror. In all good faith and simplicity he had done what he could to serve his Lord and benefit his people, and in so doing had left a name to be honored for all time.

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deal harder, yet it may still be welded. By union with a still farther quantity of carbon, it loses altogether the property of welding; is rendered harder and more compact; and forms the fine *cast steel.* Steel, therefore, though like cast iron it contains carbon, yet differs from it essentially in being destitute of oxygen and earth.

Another combination of iron and carbon, which is a true carburet of iron, is the substance called *plumbago*, or black-lead, used in fabricating pencils, and in covering iron to prevent rust. By exposure to the combined action of heat and air, the carbon is burned off, and the oxide of iron remains. When mingled also with powdered nitrate of potash, and thrown into a crucible, a deflagration ensues; and an oxide of iron, equal to about one tenth the weight of the plumbago, may be obtained by washing off the alkali of the nitre. From recent experiments of Messrs. Allen and Pepys, it appears that pure plumbago, when burnt in oxygen gas, leaves a residue of oxide of iron amounting only to about 5 *per cent.*; and that it gives very nearly the same quantity of carbonic acid, by combustion, as the diamond and charcoal. When intensely heated in a Toricellian vacuum by a Voltaic battery, Mr. Davy found that its characters remained wholly unaltered. Neither could any evidence of its containing oxygen be derived from the action of potassium. (Philosophical Transactions, 1809.)

* It has been lately suggested by Hassenfratz, and with some probability, that iron, which is manufactured with wood charcoal, owes much of its superiority to combination with potassium. (Nicholson's Journal, xxv. 51.)

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

Memoir III—Rev. Shubal Stearns.

CHAPTER ONE

The latter half of the eighteenth century was crowded with events which were of signal importance to the human race, but to the eyes and minds of many christian observers, there was a visible decline in all the elements which constitute the noblest traits in religious and moral character. The influence of four kings had reacted disastrously on the three leading nations of the world. Louis XIV. in France, Charles II. and his brother, James II. in England, and the great warrior, Frederick of Prussia, had each and all led such lives and professed such sentiments that millions of men and women were more or less debarred through their corrupting influence. The low sensualism and disregard for truth in the lives of the first three were supplemented in the ambition and atheism of the great German. It seemed that all the benefits won through the piety and heroic constancy of Martin Luther in his struggle for human emancipation, had but resulted in unbelief and contempt for all things in religion and morals. Preachers and priests vied with men of the world in their lives of shameless disregard for all the restraints incident to their holy functions. They could be found not only re echoing the doubts and sneers of Hume, Gibbon and Voltaire, but too often were also profane, adulterous and openly drunken in their lives. With such religious guides and civil governors it was not for a moment a thing to be wondered at that great masses of the people came to distrust and despise all who advocated a higher morality and a closer walk with God.

To read at this day the strictures of the Rev. Sidney Smith upon the Methodist movement under the Wesleys and Whitfield and also on the missionary efforts started by Carey and Fuller, we can faintly realize something of the utter worldliness of the great body of the clergymen of that period. Mr. Smith was even better than the majority of his brethren of the cloth and surpassed them as much in the purity of his life, as he excelled them in intellectual endowments.

Yet such a man was capable of advising the British king to arrest and punish as male factors, the brave men who had gone in want and peril to seek and to save the perishing millions of the heathen East. Nothing but that traditional love and respect of the Englishmen for individual liberty and their dogged resolution that no man, however humble, should be denied its privileges, saved Dr. Carey and his associates from speedy expulsion from Bengal. That talismanic charm which every British citizen bears along with him around the whole broad world, made the Governor General pause and forbear from carrying out the policy recommended by the great Episcopal preacher in London. But when Judson and Rice came upon the scene, no such difficulty arose in the fulfillment of his wishes. These two Americans could not, like the Apostle Paul, arrest his resentment by the plea of their birthrights. Being foreigners, they were at once driven from the land on the plea that their preaching would endanger continuance of English control.

A long and unrelenting prosecution of the Baptists, both in Great Britain and America, had greatly crippled and circumscribed their religious influence on the people of that wicked and adulterous age in the world's history. Then, too, the loose tenants of John Bunyan and his Baptist supporters touching open communion had resulted in filling their churches with crowds of unconverted people. The result of all this could be nothing else than the loss of that ancient zeal and ardor which had preserved the Baptist name and principles through long centuries of bloody persecution. The same people, who, in their dauntless constancy, had held aloft the light of truth in so many lands, being thus chained like Paul to a body of death, not only lost much of their olden faith and purity, but became oblivious of their duties as to rescuing the world from its state of enmity to God. A century earlier, Baptists were found disregarding all the bloody penalties proclaimed by kings and prelates against the promulgation of their principles and were winning souls and suffering therefor in every part of christendom.

Since the advent of Will am and Mary upon the British throne, a great degree of freedom from pains and penalties had been enjoyed, both in Great Britain and America. This toleration, as it was called, of a faith so hateful to the average Pedobaptist,

had also served to disarm and neutralize the Baptists in their traditional activity toward extending the limits of their faith and practice. In the midst of such torpor and forgetfulness of duty the Baptist people were startled like the Jews of old by two young men who were to prove themselves worthy successors of that eloquent eremite who, seventeen centuries before, had the honor of proclaiming our Saviour's advent. As John the Baptist found a world lost in sin and forgetfulness of God, so too did John Wesley and George Whitfield, Protestant and Romanist alike were sleeping on their posts, and beyond the efforts of the handful of faithful Moravians, the great work of the world's redemption seemed to have come to a complete standstill. The two young students who, amid their careless compeers at the great English University, had given their hearts to Jesus and his cause. right nobly redeemed the promises and pledges made each other in those halcyon days of their youth. Many lands and many peoples heard these wondrous heralds pleading the cause of the new birth in Christ and a closer walk with God.

It was under the magic utterances of Whitfield that Shubal Stearns was awakened to a sense of his acceptance with Christ. The name of this Baptist worthy had been long known and spelled by the people of our State as given above, but some authors give him the title of Shubael. It is too late however, to alter that which has been so long established among us, and we shall therefore continue to speak of him as did our forefathers and designate him, as of old, the Rev. Shubal Stearns. He was born January 6th, 1706, and was reared in or near the city of Boston, in the State of Massachusetts. He had been baptized according to the practice and ritual of the New England Puritans, but under the heart-searching discourses of George Whitfield first really knew the Lord. For a time after his conversion he remained a member of a New Light Congregational church, but grew dissatisfied with their views. It was thus that he came for mental peace to join himself to a Baptist flock that was then recently allowed to exist on the part of the Colonial authorities, simply because of stringent orders from London imperiously commanding the public authorities to relax in the hard hearted measures they had before exercised toward the Baptists and Quakers in their midst. In the close union of Church and State, which had so long existed in Massachusetts, there

had resulted such a state of affairs that little true and vital religion was left in the community. An outward adhesion and conformity to the Established Church had soon taken the place of all the zeal and enthusiasm of the men and women who constituted the congregation brought from beyond the seas by the good ship May Flower. In the cold and lifeless formalities of the New England people there was a large reproduction of the hateful Phariseeism so sternly denounced by our patient and merciful Saviour. So overweening and intolerant was this spirit that even the wisdom and piety of Jonathan Edwards could not avail in disarming their jealousy and resentment against every man who presumed in any way to differ in religious and political sentiment from those of this Yankee Sanhedrim. All of Dr. Edwards' fame for splendid talents, consecration to God and burning zeal in his cause would have amounted to nothing in their sight, and he, like another Roger Williams, would have been expelled from their midst but for two reasons. The first of these was that he differed only in a few vital points from their own Westminster Confession, and the second was that good William III. had secured from the British Parliament the enactment of the famous statute for toleration in all parts of the empire then under its control.

The New England Baptists had undergone unspeakable pains, penalties, robbery and humiliation at the hands of these witch-burning, slave-trading, hard-headed successors of Cromwell and Pym. Their system of government was virtually a theocracy wherein the preachers and ruling elders were the lords of the land. They were as omnipotent in the General Court of Massachusetts Bay as in the church conferences where they sat as moderators. The age, infirmities, piety and eloquence of Rev. Obadiah Holmes weighed nothing in their view when they learned that upon the request of a sick friend and brother in the Lord, this Rhode Island Baptist divine had presumed to come by request into their midst, and had actually prayed, preached and otherwise worshipped God in the house of his host. For no other infraction of law human or divine, Mr. Holmes was seized, along with him whose hospitality he was sharing, and both were condemned to undergo the extreme penalties of horrid Puritan statutes. The venerable and beloved shepherd of the Rhode Island Baptists was beaten at the public whipping-post until his back was a mass of

blood and bruises. Though smiling and rejoicing under the cruel infliction that he was counted worthy to suffer like his persecuted Lord, the good man was unable to lie upon his back and lay for weeks hovering between life and death in consequence of his injuries.

When Mr. Stearns became a Baptist, the day of such bitter intolerance seemed a thing of the past. Even Rev. Cotton Mather was heard speaking words of christian sympathy and affection toward his brethren of the Baptist church in Boston. The long arm of the British Parliament had compelled the General Court to stop in its violence, but ages yet were to elapse before these men of Massachusetts got the consent of their minds to conform to the great American rule of freedom and equality among men in their worship of God. It was full fifty years after Thomas Jefferson had secured such a blessing for Virginia and the Republic, before Massachusetts could be induced to accept in its entirety, this most sacred and inaliena ble human privilege. John Adams told the men who sided with his great Virginia rival, that his people were prepared to suffer through war and pestilence before surrendering their claim of power over the public consciences. He did all he could to prevent the insertion of this the noblest feature in the Federal Constitution, and its adoption was secured in the face of his opposition, displeasure and protest.

It can, then, well be imagined that life amid a people animated by such a spirit was embittered to such men as gentle Shubal Stearns. He and his young wife were full of happiness in their new-found faith and a great desire and prompting were thrilling in their hearts touching their duty toward God and their fellowmen. Mr. Stearns soon yielded to his sense of duty and began exercising his gifts as a preacher of righteousness. He was born in the year 1706. His father bore the same name with himself, and his mother had been a Miss Rebecca Larriford before her marriage. He was just thirty-nine years old when he joined the New Light congregation which had originated under Whitfield's preaching. For six years he continued a member of this organization. But in his study of the Bible he was forced to the conclusion that nothing therein could be found to justify infant baptism or any other substitute for immersion. He then could no longer abide where Mr. Whitfield had left him, but in 1751 was immersed into membership of a Baptist church in New

England, then under the pastoral charge of the Rev. Wait Palmer. This congregation was located at a place called Tolland in Connecticut. During the same year Mr. Stearns was ordained to the full work of the gospel ministry by a presbytery consisting of the pastor, Mr. Palmer, and Rev. Joshua Morse. Three years after this important event in his life, Mr. Stearns devoted to active evangelism among the people of New England. In this work he found many things to harass and discourage him. The same Phariseeism that had opposed and denounced the labors of Jonathan Edwards and George Whitfield, rose up to confront him. As they had shut their doors and forbidden the uses of their houses of worship to the older evangelists, so fared it with gentle Shubal Stearns. These servants of the Lord, like himself, were forced to use the hills and fields as places for meeting the multitudes that flocked in thousands to hear the new version of that ancient gospel of peace and love to all mankind. But the missionary spirit began early to prompt Shubal Stearns to go into early fields. He and his brother in-law, Rev. David Marshall, concluded that it was their duty to go to the South or West, and amid the new settlements proclaim the glad tidings in their possession. Thus it was in 1754 Mr. Stearns bade adieu to his New England home and friends and started on the mission which was so abundantly to bless our people of North Carolina.

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II. Cobalt has a greyish white colour, inclining somewhat to pink. Its specific gravity is 7.7 ; it is brittle and easily reduced to powder; is not fusible with a less heat than 130° of Wedgwood ; and, when slowly cooled, may be obtained crystallized in irregular prisms.

By exposure to the atmosphere cobalt is tarnished, but not oxidized to any extent. In an intense heat it burns with a red flame; but, if pure, it is not easily oxidized by a moderate temperature. Its oxide is of a deep blue, approaching to black. This, from the experiments of Thenard, appears to be the first oxide. It may be obtained, also, by precipitating the nitrate of cobalt with potash. The precipitate is at first blue, but when dry becomes black. It dissolves readily in muriatic acid, giving a solution which is green when concentrated, and red when diluted. Its solutions in sulphuric and nitric acids are always red.

When this oxide is exposed to the atmosphere, it gradually absorbs an additional dose of oxygen; and becomes olive green.

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

MEMOIR III—REV. SHUBAL STEARNS.

CHAPTER TWO.

Before continuing the narrative of Shubal Stearns' adventures and labors in the South, it is proper to say a few things concerning the condition of affairs in that portion of North Carolina which became the scene of his subsequent efforts in this life. During the administration of Gabriel Johnston as Governor of the Province, a prodigious influx of immigration began to pour into the Piedmont region. Two great tides flowing steadily southward from Pennsylvania, and northward from the wharves of Charleston, brought in each year thousands of men and women seeking new homes in the wilderness. They were composed of many different creeds and nationalities. The stern and fearless Scotch-Irish, the French Huguenots, the German Lutherans, the gentle Moravians, and lower down the country, the Scotch highlanders came in troops to possess the land. A few settlers came from England and Virginia to the same region, but they were like Æneas' ship after the storm—*Rari nantes in vasto gurgite.*

Amid a people thus constituted there was of course a variety of creeds and social customs. Little communities had each for it self its church and traditional festivals. The prevailing sect among them all was that of the Presbyterians. The peculiar tenets of Calvin and Knox were thus become potent in the American forest. Among these people it was a rule to bring along with each company of immigrants their pastor and ruling elders, and among the first houses built in such a settlement was one for worship and then one for the education of their children. The harsh and bloody treatment these people had undergone at the hands of the Stuart Kings of England had made their system of religion a thing for which they were educated to believe it was their duty to die whenever its defence required such a sacrifice. With all its apparent austerity and gloom as viewed by other people, it was still to them what the Temple of Jerusalem and its magnificent ceremonies had been to the Jews of old. They loved it better than life, and were ready for martyrdom at any season rather than renounce fealty to its support.

It was thus in the year 1754 that Revs. Shubal Stearns, Daniel Marshall and their families found the region peopled that they had selected for their homes. They had halted for a brief season in northern Virginia, but for reasons best known to themselves, they were persuaded that larger usefulness was promised them further south. Under the influence of their preaching, a church was at once formed on Sandy Creek. Multitudes flocked to hear this new gospel of love and freedom they were proclaiming, and very soon six hundred names were enrolled as members of the new church. They had come into North Carolina in a little company which numbered all told but sixteen souls, but in a marvellously brief season this small nucleus of hope and faith had expanded into so many other congregations, that in 1755 the new churches they had formed united in forming the Sandy Creek Association.

Shubal Stearns and Daniel Marshall must have been, both of them, preachers of unusual powers to have accomplished such wonderful things. We must remember that the scene of their labors was by no means destitute of all precious religious privileges. Not only had the Established Church sent rectors to the same region, but numerous Presbyterian and Lutheran ministers were established within reach of these same settlements In the case of Mr. Stearns we have such abundant testimony of his unusual gifts both in mental and spiritual development, that we are not astonished that the careless multitudes he found in his new home were stirred to the depths of their souls. The testimony of Rev. Dr. Robert B. Semple of Virginia, who wrote his valuable history of the Baptists of his State in A. D. 1810 is enough of itself to enable us to understand why such remarkable success waited on his efforts. He was described as a small handsome man with great impressiveness in his words and manner. But the secret of Mr. Stearns' remarkable sway over all audiences lay in the use of his voice and eyes. The one was full of melody and soul-reaching power, while the other almost realized the reputed charm possessed by some of the animals over their feathered victims. "His enemies," says Dr. Semple, "would sometimes be captivated by his musical voice. Many strange things are related of the enchanting sound of his voice, and the glance of his eyes had a meaning in every move."

Morgan Edwards says: "He was a marvelous preacher for moving the emotions and melting his audiences to tears. The most exciting stories are told about the piercing glance of his eyes and melting tones of his voice, while his appearance was that of a patriarch."

This last author quoted was, like Dr. Semple, a Baptist author and divine, who was of great distinction himself for his abilities both as an author and a minister of the gospel. We may therefore safely rest in the assurance that his picture of the pioneer preacher was in no wise overdrawn. Being his cotemporary and personal acquaintance, we can safely conclude that the extraordinary imputations of power in the pulpit were in no respect overdrawn.

Another witness as to these great and unusual gifts in the keeping of Mr. Stearns, was the Rev. Tidence Lane. This man, who was to become so honored and useful as a Baptist preacher, was a bitter foe of our peculiar articles of faith and practice at the time of his first meeting with Shubal Stearns. "Upon my arrival," says Mr. Lane, "I saw a venerable old man sitting under a peach tree, with a book in his hand, and the people gathering about him. He fixed his eyes upon me immediately, which made me feel in such a manner as I had never felt before. I turned to quit the place, but could not proceed far. I walked about sometimes catching his eyes as I walked. My uneasiness increased and became intolerable. I went up to him, thinking that a salutation and shaking of hands would relieve me; but it happened otherwise. I began to think that he had an evil eye and ought to be shunned; but shunning him I could no more effect than a bird can shun a rattlesnake, when it fixes its eyes upon it. When he began to preach, my perturbations increased, so that nature could no longer support them, and I sank to the ground."

To cold and sceptical minds this may sound not only incredible but the raving of one who was of unsound mind. The grace of God has ever thus appeared to the average Greek, foolishness, just as it was a stumbling block to the Jews. But if we can trust truth of history at all, things just as marvelous are related on the highest and best authority of the effects waiting on the sermons of Whitfield. Dr. Armitage, in his Baptist history, has preserved the following instance of the great preacher's influence over his hearers:

"It is stated on good authority that the parsonage at Center Groton was the scene of one of the most remarkable sermons of of this great preacher. The upper windows of the house were removed and a platform raised in front, facing a large yard full of trees. When Whitfield passed through the window to the stand, he cast his eye over the multitude and saw a number of young men who, imitating Zaccheus in the sycamore tree, had climbed these trees and were perched on the limbs. The kindly orator asked them to come down, saying: 'Sometimes the power of God falls on these occasions and takes away the might of strong men. I wish to benefit your souls and not have your bodies fall out these trees.' He expected to see them come down to the ground as birds that were shot, and choosing the valor of discretion, they came down only to be prostrated under the sermon. Great numbers went home to lead new lives, and it is said that more than one of those young men became preachers of the new faith."

As greatly as Mr. Stearns was favored of God in the conversion of his new neighbors and compatriots, he was still subjected to much difficulty and embarrassment. In the work of setting up new churches and in ordaining new ministers of the gospel, he was powerless to form a presbytery for the want of some other ordained preacher. Mr. Marshall was only a licentiate and so was Joseph Breed. All other Baptist preachers in reach were members of the Regular branch of the denomination, and in their disfavor toward the New Light doctrines, refused to bear any part in the ceremony. But it so happened that the Rev. Henry Ledbetter, who was also a brother-in-law of Mr. Stearns, fortunately about that time came South, and by joining him in the work relieved him of all the trouble occasioned by the want of help from others.

Thus like another apostle of the true faith came Shubal Stearns to seek and to save that which was lost amid the forests of North Carolina. Far from home and kindred, he had come to impart to others the same great blessings that God in his goodness had provided for his faithful servant. Amid the Baptist churches, planted under his own ministry, he spent the short remnant of his days on earth. In the closing scenes of his long pilgrimage, he was saddened in the stress of war and calamity. Gov. Tryon and his evil subordinates were making life bitter to thousands who found it impossible to sustain their families and comply with the enormous exactions of the extortionate sheriffs and other civil authorities.

These agents of the Devil were not content with impoverishing the poor people by exacting unlawful fees and assessments, for in the fullness of their malicious wrong doing, the wives and daughters of the people were too often subjected to insult and humiliation at their hands. The gentle spirit of good Shubal Stearns, almost ready to take its flight for another and better world, was grieved and depressed by these wrongs on his people that he was powerless to redress. But brave men in North Carolina have never been found submitting to such treatment without a proper show of their disapprobation and resentment. It was thus that Mr. Stearns' brethren and neighbors were found the first of all the Province to meet in solemn conclave, and, after mature deliberation, declare to the world their resolutions in view of such oppression. This occurred on March 27th, 1767, full three years before the last tragic scene in the dreadful drama of blood and confusion which was witnessed in the battle of Alamance. These were really the first guns fired in that great American uprising for freedom and national independence.

The soul of the venerable father in Israel had its compensations for all such troubles as were born of this War of the Regulation. He saw the faith he had first inculcated in North Carolina widening and deepening around him with the lapse of each revolving year. Then, too, that famous Baptist preacher of New York, the Rev. John Gano, came down South and for a season also made his home in North Carolina. The old man eloquent heard this wondrous young preacher as he rose to still sublimer heights than it had been permitted Shubal Stearns to reach. That magic eloquence, which was in after years to so often charm Gen. Washington and his armies, was then cheering him and the Sandy Creek people. The genius and faith of the younger man was a rare blessing to the tender and faltering spirit of the spent veteran, who in the chill and weakness of old age was at times subject to spells of mental and spiritual depression. Because of his enfeebled body, the sensitive spirit of Mr. Stearns was troubled that he no longer felt all the thrill and rapture of former years. He had never a doubt of the goodness and favor of God, but at times grew depressed at a sense of his own unworthiness. But this was only a temporary trial of his faith. As the night of death drew nigh, all the older power and confidence were his again; and thus, when the 20th of November, 1771, was come, Shubal Stearns

had passed beyond the reach of all trials and temptations of this life, and was with the gracious Master he had so long served.

"Duncan is in his grave
After life's fitful fever he sleeps well.
Treason has done his worst; nor steel, nor poison
Malice domestic, foreign levy, nothing,
Can touch him further."

He had done a great work in his stay with our people, and in a comparatively brief interval had wrought such blessings for those among whom he cast his lot, that his is now "one of the few immortal names that were not born to die."

which ha… …is discov-
ery has l… …stimony of
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Cerite.

II. To … …is dissolv-
ed in nit… …pulverized.
The solution is filtered, neutralized with pure potash, and then precipitated by tartrite of potash. This precipitate, well washed, and afterwards calcined, is the oxide of cerium.

III. Cerium appears to be susceptible of two stages of oxidizement; the first oxide being white, and the second of a fallow red. The white oxide, by calcination, becomes red.

IV. Sulphuric acid, diluted with four times its weight of water, dissolves the red oxide. The solution, on being evaporated, yields crystals, some of which are orange, and others have a lemon-yellow colour. The sulphate is soluble only by an excess of acid. Its taste is saccharine mixed with acid.

V. Sulphuric acid readily unites with the white oxide; the solution is nearly colourless, but has a slight rosy tinge. It has a saccharine taste, unmixed with acidity, and yields white crystals.

VI. Nitric acid unites most easily with the white oxide. The solution is very sweet, and is not crystallizable. When decomposed by heat, it leaves a brick-coloured oxide.

VII. Muriatic acid dissolves the red oxide; and the solution crystallizes confusedly. The salt is deliquescent; soluble in an equal weight of water; and in three or four parts of alcohol. When this solution is concentrated, it burns with a yellow sparkling flame.

An infusion of galls produces, in muriate of cerium, a yellowish precipitate not very abundant. A few drops of ammonia throw down a very voluminous one of a brown colour, which becomes black and brilliant, by desiccation. By the action of heat, it assumes a brick-red colour.

VIII. Oxide of cerium unites readily with carbonic acid. This union is best effected, by precipitating a solution of the oxide with carbonate of potash. An effervescence ensues; and a white and light precipitate is formed, which assumes, on drying, a silvery appearance.

IX. Sulphuretted hydrogen does not unite with cerium.

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

Memoir IV—Rev. Daniel Marshall

CHAPTER ONE.

Perhaps no people have yet lived in this world with so broad and cosmopolitan a spirit as has been exemplified in North Carolina. From the earliest times in her history as a civilized community, not only kindness and the most abounding hospitality have been shown to strangers; but to every new-comer, whatever his nationality, an equal share of honor and trust has been extended, whenever such a man was worthy and fit for such marks of distinction. So far from our people manifesting anything of a spirit of jealousy toward our citizens of alien birth, it has really seemed that such an accident of nativity has worked in their favor, and in a thousand instances has given them the preference in popular favor over those who were so unfortunate as to be to "the manor born." Whatever may be said of the wisdom and propriety of such a trait, it at least proves the large-hearted and unselfish disposition of our people. With such a spirit and characteristic as a civilized community, it would be unpardonable if the life and labors of the Rev. Daniel Marshall were omitted from a catalogue of our pioneer Baptist preachers.

Like Shubal Stearns, Daniel Marshall was born in the year of our Lord 1706. This event occurred in the town of Windsor of the then Province of Connecticut. He was reared by a Presbyterian father and mother, and upon reaching years of maturity was admitted to all the rights and privileges of the church to which his parents belonged. This was a matter of course in Presbyterian practice, and was only remitted in such cases where the young men and women who had been christened in unconscious infancy destroyed all hope and imputation of virtue therein by outbreaking and abandoned courses of life. As this young Daniel Marshall not only conformed to the usual standard of morality, but was also a believer in the articles of faith set forth in the Westminister Confession, he was not only made a member in full standing, but also in due season was appointed a deacon of his church. He had also married a wife in the meanwhile, and saw children blooming like flowers in the household blessed by his thrifty and prosperous oversight.

Until Daniel Marshall reached the turning of life in his thirty-ninth year, and thus saw his sun of existence reach its prime and begin the slow years of decline and decay, he lived on as he saw his friends and brethren did, in their cold and formal compliance with set rules of morality. In Connecticut this Presbyterian system had been made the religion of the Province with all the rights and authority of other established churches. All other forms of christian faith faith were only tolerated, as it was called in that day, because the great folks in London had of late changed their policy of persecution, and had furthermore sent word to every provincial governor in America that a like policy must mark their course toward dissenters. Up to the happening of this thrice-blessed change, the lives of all New England Baptists, outside of Rhode Island, had been full of peril and hardships. They were not only liable to pains and penalties as the result of their want of conformity, but too often their land other property were taken from them to help in the construction of church buildings to be used by their neighbors who had thus robbed and punished them.

As State systems of christian faith had resulted in Great Britain and the continent of Europe, so did they in New England. The pristine fervor and devotion gradually diminished until, in the lapse of time, the machine morality, thus inculcated, ripened into such doubt and unbelief that the men and women, whose greatest means of wealth arose from slave-trading and rum-selling, became virtual infidels. They called themselves Unitarians, and thereby denied the divinity of our Saviour. In the grip of a creed thus grown stale and outworn, Daniel Marshall was ere long to see how hostile his church brethren would prove themselves to anything like the true preaching and practice of the gospel of peace. It was first seen in their rejection and scorn of Jonathan Edwards' pleas for the necessity of the new birth. When this great philosopher and theologian recalled the language of our Lord in his night talk with Nicodemus, and insisted that the Son of God was in earnest about what he told the Jewish ruler, the New England Pharisees were as deaf and blind as those of old, and, like their prototypes, they made life unhappy to all those who thus conformed to our Lord's teachings concerning this deep and awful mystery in the gospel plan of salvation.

But while church establishments and unhallowed channels of commercial traffic had

thus reacted so disastrously on the general spiritual life in New England, there were many noble exceptions to this general rule. There were still men and women left there who had never bowed the knee to Baal. The race of men who had made that stern and inhospitable clime not only to blossom as a rose, but it was also become largely the paladium and shrine for the largest and best hopes of the human race. Amid their frozen hills and storm-smitten coasts, men were nurturing a spirit of liberty and good will, which was in later years to prove a blessing to their descendants and mankind at large. Whatever their theological errors, they were yet true to the best interests of our race in their temporal concerns. Neither the might of banded kings, nor the fury of their Indian allies, could palsy that high New England spirit which sent so many of her sons to battle for the defence of free America.

Mr. Daniel Marshall was living, as he supposed, in the peace of God and in the enjoyment of the favor and confidence of such a people, when, in his thirty-ninth year, there came a moral earthquake and consequent upheaval of the spiritual dry bones. That mighty and glorious servant of the Most High, Rev. George Whitfield, like another Jonah amid the Ninevites, had come to show the careless New England multitudes how far they had come short in their duty to God. It was all in vain that the church authorities opposed and denounced this terrible exposer of their weakness and decay. Though they shut their church doors upon him, yet the broad fair fields and forests could still be used as standing ground for the vast multitudes that flocked to hear this matchless christian orator tell of what they had forgotten and overlooked in their careless reading of the New Testament. The burden of his discourse was ever the necessity of faith, repentance and a changed heart in those who would flee the wrath of God. Like John the Baptist, exposing the emptiness of Jewish hopes, so did Whitfield uproot and confound the souls that had been so long reposing on beds of mere formality. The necessity of the new birth, its mysterious dependence on the workings of the Holy Spirit, and the soul's sense of acceptance through the merits of our Lord's atonement, were almost like the preaching of a new gospel to the callous formalists. It was hateful and terrifying to their souls, just as the gracious discourses of the Redeemer had been to their ancient prototypes. As the Pharisees had resented the offers of our Sa-

viour's terms, and refused him the privileges of their sanctuaries, so did they of New England shut up their hearts and church doors against this new apostle of righteousness.

Daniel Marshall had been in all the years of his professed christian life no better or worse than the multitude of his professing brethren. Like them he had been baptized in unconscious infancy, and as a matter of course, upon arriving at the years of discretion, he had been inducted into full fellowship in the church of his family and friends. Not only this, he had been so orderly in his walk and active in his church duties, he was made a deacon of the congregation. With all these testimonials from his friends and brethren touching his walk as a christian, he was yet made conscious of his exceeding needs when the true significance of our Lord's words to Nicodemus were at last impressed upon his soul. In an agony of grief and repentance over his blindness and disregard of the Master's teaching, he cast all his old professions behind him as so many filthy rags, and, through a new-found faith, reached "the peace of God which passeth all human understanding."

In the tremendous upheaval and renewal of christian life thus brought about under the evangel of Mr. Whitfield, Mr. Marshall, like a great host of other men, turned from all secular occupations, and began that life of devotion to the Master which was to embrace the whole remnant of his stay in this world. In his new-born zeal he at once began the preaching of that gospel which had been so long in reaching and filling his own soul. Nor was he content to thus discharge a sense of duty in proclaiming Christ to his civilized countrymen. In his burning zeal, the souls of the perishing heathen lay heavy upon his heart, and we find him proceeding to the headwaters of Susquehannah river as a missionary to the Indians. The war between the tribes and white people arrested him in these labors, and he went South to continue the work thus made impossible at the North. It was thus the Rev. Shubal Stearns found him in 1753 laboring among the settlers of Northern Virginia, around a place known as Opequon. There were many things in common between the two evangelists to bind them into unusual affection and brotherhood. They were the *avaunt couriers* of that great New Light Baptist

* By *acidula* are to be understood salts with an excess of acid, such as super-oxalate of potash, &c.

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

Memoir IV—Rev. Daniel Marshall.

CHAPTER TWO.

When the Rev. Daniel Marshall came to the conclusion that it was his duty to bear the glad tidings he had so recently accepted in all their fulness to the Mohawk Indians, he was living on his Connecticut farm. This plantation was so well stocked and so productive, that he and his family were in circumstances of great ease and comfort, so far as mere worldly prosperity was concerned. With a wife who returned all his overflowing affection, and three children, it would seem that a mighty conviction of duty must have lain at the bottom of the impulse that broke up all this beautiful home life of ease and comfort, to undertake the hard and perilous mission among the savages. Nothing could more forcibly demonstrate the zeal and unselfishness of the man. Like the Apostle Paul, he gave up all things in his devotion to what he felt called to do in the Lord's service. He had not become a Baptist in all his sentiments until he reached the little Baptist church in Opequon near Winchester in Virginia. This occurred in his forty-eighth year, so we see that he was almost an old man before he became fully identified with us as a denomination.

But though so late in reaching such conclusions, Mr. Marshall's subsequent course in life was to largely atone for all delay in the performance of so momentous a duty. It was so provided that in one of his missions in the Old Dominion, that he was so happy as to include Col. Samuel Harris among the number of his converts. This gentleman by his talents and social eminence had exerted great influence in Virginia, and a mighty stir was made in Episcopal circles by the news of his conversion and joining the Baptist church. Under the Royal Governor he had been appointed commander of one of the forts which were kept garrisoned at that day as a defence against the great northwestern tribes of Indians. Col. Harris at once resigned this and all other secular employments, and became a renowned and effective agent in the spread of Baptist principles. Perhaps not even the Rev. John Leland did more to make the

State so great a center of Baptist influence. Mr. Marshall, with such a coadjutor, became mighty in the pulling down of strongholds. Over all that broad region south of James river, like Paul and Silas, these two evangelists pressed on in their work until scarce a man could be found who had not been warned and invited to accept of the terms of a salvation so sweeping and broadcast in its terms and limits.

It was all in vain that the authorities and adherents of the Established Church in Virginia sought to put a stop to such an evangel by invoking the aid of the legal authorities. They filled the loathsome jails with Baptist preachers on the false pretence that these ministers of peace and righteousness were disturbers of the public peace. Men who were so meek and gentle that they refused to resent the most wanton and inexcusable invasions on their personal rights, were held up to public scorn as malefactors for no other reason than their efforts to seek and to save perishing souls. It is one of the world's ablest epics to tell of what moral heroism these Baptist evangelists displayed in their battle with the intrenched hosts of the intolerant Churchmen. Even as late as that time, when James Madison had become a leader in public affairs in one of his letters we are told of how five blameless and eloquent men of God lay confined for tedious weeks in his vicinity simply because they had felt it their duty to preach the gospel of Christ as they believed it in their hearts and souls. It was all in vain that the statute of 1st William and Mary had proclaimed toleration to every part of the British Empire. These promoters of both the law and the gospel, on the false plea that the Baptist preachers were disturbers of the public peace, could find magistrates of their own faith who were wicked enough to thus violate laws both human and divine.

But in these, as in almost all other, instances of such oppression, the blood of the martyrs became the seed of the church. In spite of all the injustice and suffering undergone, the evangelists bore bravely on the Baptist banners until the persecuting Churchmen had but a pitiful remnant of the people left to do their bidding. The work thus bravely executed was also to be further blessed. It not only held the ground thus gained under suffering and tears; the great mind of Thomas Jefferson and that of his compeer Madison were to be not only enlisted for the defence of the Baptist people, but in due season to evolve from a study of their practice and principles the grandest

features of our civil polity as a republic. Most emphatically in this way had the stone which was rejected by the builders, become the head of the corner."

When Mr. Marshall was ordained to the full gospel ministry by his brothers-in-law, the Rev. Messrs. Stearns and Ledbetter, he assumed the pastorate of the church on Abbott's Creek. While thus serving this flock as a special duty, he was also abundant and unceasing in his excursions to distant points to thus bear abroad the glad tiding of peace and love. This work had become as necessary to his peace of mind as the air he breathed. He could find no peace with the knowledge that men and women within reach were yet unblest with the knowledge of the Lord. He met no such stern antagonisms in North Carolina as were vouchsafed in Virginia and were to be encountered still later in his life in Georgia. Gov. Tryon and his subordinates in the Provincial Government were very harsh and unfeeling too often in their treatment of our people, but in religious matters he concerned himself no further than to do all he could toward saddling Episcopal rectors on communities that rarely wished for such gifts. In some of his letters he expressed great scorn for all people who were so besotted as to hold Baptist sentiments, but he had seen too much of the danger of his interfering with popular liberty in the stamp act trouble to venture on anything like religious persecution. It may be that the imprisonment of the Newbern Baptists had the officious countenance of the Governor, but if so, we now lack evidence of the fact. As a rule, religious liberty was ever the undisputed right of all North Carolina people without any regard to the nature of their creeds.

Thus abundant in labors and highly blessed in all that he undertook in the Lord's service, Mr. Marshall spent the term of his residence in the Old North State. He saw the feeble beginnings of his and Mr. Stearns' labors expand into the great historic body known as the Sandy Creek Baptist Association, and he heard many moving accounts of how under Burkitt and the New Light doctrines were prospering in the Albemarle region.

Mr. Marshall had but one son by his first wife, but being so unfortunate as to lose her, he married again in 1748 Miss Martha, a sister of the Rev. Shubal Stearns. This remarkable woman proved a rare blessing to her husband and all others who came within the magic spell of her personal influence.

She was as famous as her husband for her zeal and devotion. With no disposition to usurp the religious functions peculiar to male members of orthodox christian churches, she could still on proper occasion melt the hearts of all who heard her in prayer and exhortation. Her oldest son, the Rev. Abraham Marshall, won a great place in the love and admiration of his countrymen for his piety and eloquence. With him and numerous other descendents around her, Mrs. Marshall survived to extreme old age.

In those pre-revolutionary days in our history as a people, there was no little talk and belief in the near approach of the millenium. At one period of his life Mr. Marshall was a firm adherent of this persuasion, which had originated in America just previous to the advent of John Wesley and George Whitfield. Multitudes were in daily expectation of the second coming of our Lord, and they produced a great awakening in the hearts of the people. The most careless and unbelieving, seeing such men as Daniel Marshall abandoning their comfortable homes and forsaking everything in the shape of property in their zeal for the cause, profoundly dreaded the possibility of such an event as that which was so confidently predicted. With the popular mind thus possessed with the possibility of such an event as the second coming of our Lord, it is not wonderful that multitudes so impressed should have sought safety, both for soul and body, by making a full surrender of all their rebellious and sceptical promptings, and in seeking a part in the great atonement accomplished for all true believers on Calvary. When the times of such religious excitement over the expected coming of our Lord have passed by with nothing to justify such an expectation, it is too common for worldly people and too many professed christians to sneer at the credulity of such dupes, as they are called; but let all such remember that the Master himself declared that this momentous incident of the coming ages was to be as a thief in the night in the matter of its approach. Then let no man sneer at his brother for a mistake concerning this tremendous and uncertain event which so surely awaits its fulfilment somewhere in the coming years. If not even the angels can foretell that day and hour, it may be well pardoned in any human intelligence that it should be mistaken in surmises on this subject.

Mr. Daniel Marshall was not a Baptist when he indulged in his anticipations of our Lord's speedy coming again on earth. Laborious and useful years of service, both among his own countrymen and the heathen

Mohawks, intervened between such an expectation and his acceptance of the truth as Baptists hold it. If he ever was vain and fantastic in this respect, it was before he became a member of the Virginia Baptist church. Let us remember, too, that if our Saviour had thus failed to realize the anticipations of his faithful servant, this disappointment worked no abatement in his zeal and devotion to the great work of deliverance from sin and of fealty to the Prince of Peace. Like a tireless and valiant soldier of the Cross, the Rev. Daniel Marshall became, if anything, more eager than ever to spend and be spent in the sacred work of human salvation.

It was thus that ere long Daniel Marshall was again found turning away from home and all its creature comforts to undergo hardships and sufferings in another missionary journey and settlement in the Province of Georgia. There selecting a home near what is now the city of Augusta, he resumed the work he had so successfully prosecuted in so many previous fields of labor. The same fervor of soul and pathetic eloquence were his as he implored his new neighbors to seek the salvation which was so free to all who will only open their sinful hearts for its entrance. The old man more eloquent and dauntless than ever paused never a moment in his work by reason of human obstacles. It was in vain that the civil and religious authorities of St. Paul's Parish procured his arrest and temporary imprisonment. Repeating Peter and John's reply to the Sanhedrim's command and enjoining their cessation of proclaiming the resurrection and ascension of our Lord, he told his tormentors that their orders for his silence in their bailiwick were impossible of being complied with on his part. That as the herald of our Lord's coming kingdom in their midst, his duties were of such a nature as to transcend and overshadow in importance all the laws and injunctions framed by human authorities. Not even when in the midst of the Revolution he fell captive to his British enemies, did his fortitude forsake him. Having asked and obtained permission of the officer in charge to speak and pray for these enemies of himself and his cherished American cause, he so impressed them that they at once gave [illegible]. Thus in faithful service to God and his fellowmen the good old man labored on in his mission until on the 2nd day of November, 1784, he rested from his long and useful career among men and went to receive the reward awaiting the redeemed.

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Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

MEMOIR V—REV. LEMUEL BURKITT.

CHAPTER ONE.

The greatest of all the poets has declared that "there is a tide in the affairs of men which, taken at its flood, leads on to fortune." Doubtless time and opportunity have greatly controlled the changing aspects of individual and national advancement; but on the other hand, there have been men whom it would be difficult to associate in our reflections with any possibility of mediocrity in their relations to their several environments. Where could an Alexander, a Cæsar, or a Napoleon, have been placed, or, under what circumstances existing, which would have resulted in making them either mute, inglorious Miltons or village Hampdens? Such a suggestion will be at once set down by well informed people as something impossible and beyond all range of moral sequence. The dauntless hearts and imperious minds of these mighty kings of men were as much beyond the control of law, precedent and human conventionality, as their fame exceeds the usual ratio allotted to successful adventurers. They were like the stars and dwelt apart in the solitude of their native greatness and originality. Had there been no possibility of Gallic or civil wars, Cæsar would have yet been immortal as the rival, if not the superior, of Cicero as an orator, and of Tacitus and Livy as a historian. So, too, the Code Napoleon is of itself enough to demonstrate how the mightiest of modern soldiers would have shone in the civil development of his beloved France. With all these things being admitted, there yet remains no doubt that in even their cases the man and times had met. Golden opportunity flung wide open the glowing portals each was so eager to enter; and thus in happy coincidence each made the most of what his own genius and fortune had made possible.

While it may seem a little like the logicians' *reductio ad absurdum*, to preface the memoir of an humble Baptist preacher with analogy between himself and such grand historic figures as have been referred to, yet to borrow an idea again from the mighty dramatist, "One touch of nature makes the whole world akin." These conquerors and

scourges of the human race were far inferior as to any good they accomplished to many a man who asked for no higher honors than those won in proclaiming a crucified Saviour. History holds record of no more glorious and picturesque figure than that of him who, arising from his blindness and pharisaical enmity, went forth to lift up and instruct the people of so many different nationalities. While subsequent records contain no such an evangelist as Saul of Tarsus became, though in his genius, culture, fearlessness and devotion, he will be ever unapproachable, yet it has pleased God to raise up other men of largely similar aspects. To the life and services of such a preacher of righteousness, this memoir, with all due candor, invites the kindly attention of the reader.

In all the long catalogue of Baptist preachers who, in the last two centuries, have lived and labored for the Lord in North Carolina, no greater name appears than that of Lemuel Burkitt. He is yet indeed, in largeness and variety of his gifts, in the abundance and beneficence of his works, and the power of his influence, unequaled in all our history as a civilized people. Though born amid all the comparative poverty and disadvantages marking the condition of the great body of our people in that period, he rose superior to the tramels of birth and place, and made himself as great in knowledge as he was in true godliness. That a man-child so ushered into the world, amid humble and unlettered associates, should, by his almost unaided efforts, so overcome every obstacle to education and consideration among his countrymen, goes far toward vindicating the opening generalization of this memoir. Lemuel Burkitt neither waited for time or tide in human affairs to lead him on in that grand pathway of consecration in the service of God and his fellowmen, which, in due season, won him such glorious guerdons. Like the great Duke of Wellington, "The pathway of duty was his road to glory." He shed no human gore even in the rightful defence of his native land. He followed no glittering baubles of pride and ambition. His manhood was spent first in laborious self-preparation, and then in the most ardent and ceaseless labors for the lifting up of the minds and spirits of his people.

With so noble an ideal ever leading him on, Lemuel Burkitt became in due season to the Baptist churches in eastern Virginia and North Carolina almost as potent a guide as was Martin Luther amid the Germans of

* Linnæan Transactions, 1797.

his time. Not only revered as the foremost preacher amid his clerical peers, he was also a reformer to chasten and elevate both creed and practice in the churches, he found so disorganized and purposeless. He it was, above all others, that induced these congregations to give over their jealousies and fears in the preparation for a closer union in the Lord by means of a reformation of the churches. To his vast and tireless exertions as missionary in distant regions, he added another grace in his written records of his times as to their religious aspects. Thus be became thrice over entitled to undying recollection and praise.

Mr. Burkitt was born in Chowan county in the year of our Lord 1750. His parents were not blessed with wealth or much knowledge of books. They were like the great body of their countrymen, plain, hard-working people, who, in the utter want of public schools, were thus unable to afford any large advantages to their eager and intelligent boy. It is true, that the towns of Edenton, Newbern and Wilmington in the east, and the Transylvania academies of the western settlements, were in existence, but to the poverty of the Burkitt family they were as inaccessible as were Oxford and Cambridge Universities in England. No doubt, at rare intervals, little Lemuel Burkitt went along with his parents and saw in Edenton the pomp of the Colonial courts, as, amid an army of sheriffs with drawn swords, the judges, in their bag wigs and gowns, opened in the King's name their solemn proceedings. He saw a still more imposing pageant each winter, if in Edenton when the General Assembly met. The wharves, too, of that ancient capital were thronged at that day with vessels from beyond the seas and those engaged in the New England and West India trade. Edenton was the foremost port of entry and thus held a paramount importance among the sister towns of the Province.

To a boy of Lemuel Burkitt's natural acuteness such opportunities of seeing the higher aspects of human life were by no means lost. No doubt St. Paul's Episcopal church, with surpliced rector and its organ and choir, came in also for its due portion of impressions on the sensitive and imaginative soul of the lad. The grand harmonies of the chants, the pomp and beauty of the liturgy, were alike a revelation and inspiration to him, as they have been to countless others, who have listened spell-bound to

these noble prayers and confessions of the soul uttered by the great prelates of the past.

But with all these impressive accessories to her system of worship, the English church failed to satisfy the longings of Lemuel Burkitt's soul. He had made himself scholar enough to read King James' English version of the Holy Scriptures, and he had heard more than one Baptist evangelist giving his gloss as to the disputed points in the New Testament. The great problems which are ever suggesting themselves to the heart of man were not wanting in the early experience of this acute and profound human intelligence. He could understand how the wisest of men had come to the deep question of "wherein shall a young man cleanse his way?" In the mystery and suggestions of the right reason, these fearful self-questionings could not be evaded, however successful he might be in the companionship and pangs of the day's duties. "What shall it profit a man to gain the whole world and lose his own soul?" cried the Son of God, and the words came to Lemuel Burkitt with all the sanctions they had known with the multitudes on the plains of Galilee. In such communion with his own spirit, Lemuel Burkitt fled for refuge to that divine love and compassion, in whose unfailing help so many myriads of other agonized souls have found peace and rest. In his nineteenth year he thus made an open profession of religion and became a member of the Baptist church, then known as Camden, but was really the old mother-stock, Shiloh. He was baptized by Rev. Henry Abbott. There is now no account of any other Baptist church in all the region of old Albemarle east of Chowan river and north of the sound. There was Meherrin in Hertford, Sandy Run in Bertie, and Kehukee in Halifax. It was thus only by some considerable travel that Mr. Burkitt could reach any congregation of his own faith and order.

He was not alone in his glory as a leader of men in the ancient bailiwick of Chowan. There were a score or more of gentlemen known and honored all over the Province who then had their residence in its limits. That learned jurist, Mr. Barker, who was the law tutor of Gov. Samuel Johnston, was yet the greatest name in the courts. Mr. Samuel Johnston and Mr. James Iredell, his brother-in-law, were to reach even higher honors and renown that was ever the fortune of their instructor. Besides these legal and civil luminaries Edenton numbered in

its inhabitants. the Pollocks, Benburys, Swains, Brownriggs, Johnsons, Creecys, Jones's, and other families noted for wealth and culture. Reared in such a community, it was no wonder that Mr. Burkitt should have been incited to early and strenuous efforts at self-improvement in mind as well as the more solemn and important matter of escape from wrath to come in the next world. Like many more of his North Carolina compeers, this work of education and mental discipline was to be almost wholly dependeut upon his own unaided exertions. Reference has already been made to the great dearth of schools in the Province. There was a parallel want of books also. Indeed the lists of the literary treasures included in the libraries of the richest and most intell gent men of that day seems pitiable to the minds of men who, in this generation, rejoice in su·h overflowing abundance. A few great men might add Shakespeare's and Addison's works to their English Bible, but all other British and French classics were conspicuous by their absence. It is probable that Elder Burkitt's whole literary repertory was included in the Bible, Pilgrim's Progress, Watts' Hymns and Gill's Theology. Not even the wisdom of Dr. Johnson or the wit of Pryor and Steele had as yet triumphed over the double obstacles of an intervening ocean and the stolid ignorance of the people. The sole reliance of the great mass of the North Carolinians of that day, in the matter of educating their children in the first rudiments of literary culture, was in the homeless wanderers, who passed from settlement to settlement and for brief seasons would halt long enough to teach for a brief season the children of their temporary vicinage. They thus got food and lodging by quartering on first one family and then another, and in addition won a stipend, meagre at best for his labors in the log school house. These restless peripatetics were thus too general in their favors to work much benefit at any single scene in their careers. To such instructors the great preacher of the future was indebted for all the small aid he received in fitting himself for the future that as yet seemed so hopeless to his most ardent imaginings.

We may imagine, but would be utterly unable to describe, the added anguish of soul that came to young Lemuel Burkitt when, in God's providence, he had become

convinced of his duty to devote his life to a proclamation of the gospel. With all his peerless native endowments both as to mind and energy of purpose, he found at every step of his study, not only of Gill's Theology but in the sacred text itself, a thousand things that were all riddle and darkness. His ignorance of the orientalisms and figures of Hebrew speech, the confusing historical and geographical allusions, and the thousand other things which dishearten and dismay every scholar unfitted by want of previous preparation to comprehend the task before him. But the race is not always to the swift. Determination, love and prayer have unlocked all that is needed to be known in God's word to countless others far less competent to struggle with such difficulties as thus beset Mr. Burkitt in his first efforts in such a field. His want of early preparation made his way to knowledge far more difficult and protracted, but his genius, supported both by religious zeal and native resolution, in the end enabled him to become both prophet and priest to his admiring and devoted countrymen.

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8. Alcohol, when transmitted through a red-hot copper tube is decomposed. The tube is found lined with a very fine light soot resembling lamp-black, and an enormous quantity of carburetted hydrogen gas is evolved, not less, as appears from an experiment of Van Marum, than ten cubic feet by the decomposition of three ounces of alcohol. From the analysis of this gas, Mr. Cruickshank has inferred that in alcohol the carbon is to the hydrogen in the proportion of 4 to 1.*

9. In order to determine accurately the composition of alcohol, Lavoisier burned a quantity with very minute attention to the products. The weight of alcohol consumed amounted to 93.5 grains, and 110.32 grains of oxygen were expended in the combustion. The water produced amounted to 106.2 grains, and the carbonic acid to 98.8. From the known quantity of carbon in carbonic acid, and of hydrogen in water, Lavoisier inferred that the alcohol, on which he operated, consisted of

Carbon - - - - -	28.53
Hydrogen - - - - -	7.87
Water (existing in the alcohol) -	63.6
	100

Comparing, then, the composition of alcohol with that of sugar (a compound, as has already been stated, of 8 parts hydrogen, 64

* Nicholson's Journal, 4to. v. 7.

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

MEMOIR V—REV. LEMUEL BURKITT.

CHAPTER TWO.

Our last chapter left the subject of this memoir in the midst of his first trials and difficulties encountered in his work of fitting himself for the gospel ministry. He was neither so ignorant as to be blind to his many needs, nor yet so conceited as to dream that any facility of speech and elocution would atone for his want of knowledge. Unlettered as he was, his natural acuteness and logical turn of mind enabled him to see how utterly some of the good old preachers of that day failed in their efforts at expounding things beyond their apprehension. He saw that in most of them that beyond their rhapsodies over the love and grace of God and the final perseverance of the saints, there was little left as topics of discourse. Of course, they never forgot or failed to remind their hearers of the paramount doctrine touching immersion, but this could be only done in a very brief and perfunctory manner. Few of them knew anything of the matter beyond the statements of the New Testament evangelists. The irrefutable and fixed truth of history, showing how the Romish popes and councils had changed and perverted the ordinance was beyond their studies on the subject. While it was very true that the Bible statements were of themselves enough to settle the matter for all reasonable minds, there were still many men and women who were staggered by the questions of Rev. Mr. Charles Earle, when he asked his Baptist neighbors how it could be that so many millions of other christians had for centuries been sprinkling their babies instead of immersing their adult converts to a new style of life. The whole mystery of the Romish iniquity, in its high-handed perversions of the early christian ordinances, were so little known that the Episcopal clergyman could thus darken counsel and distress his unlettered competitors; but at best how could so able and just a man think that such fencing with the truth was a part of his great duty in "justifying the ways of God with men"? Mr. Earle knew even better than Lemuel

Burkitt, or any other Baptist of Albemarle, in that early day, that they were practicing the precise rite used by John the Baptist and the apostles, yet he accepted as authoritative and rightful a change in Bible practice on no better grounds than the decrees of a sect his church had been for centuries denouncing as the brood of the scarlet woman, and had put to death as traitors and heretics thousands who had dared avow faith in Rome on English soil.

But let us ever be thankful to God that while her man-leavening is invaluable in its sphere, and always a mighty helper to the man who undertakes to expound the mysteries of godliness, yet at the same time the divine goodness has so ordered that those things really necessary to be understood in the Bible plan of salvation are so plainly set forth that even the wayfaring man may not err therein. Popes, prelates and councils on the one hand, and synods and conferences on the other, may set forth their interpretations of what they hold as truth, but the ultimate appeal of every true enquirer as to the way which leads to life eternal must ever remain in the imperishable chart God has given us as a lamp for our feet. It was on such safe and traditional courses that young Lemuel Burkitt turned from human glosses and gathered for himself from the fountain head of truth the rules of his own faith and practice. How with such meager aids to higher attainments he managed so soon to shine as a star among his humbler brethren in the Baptist ministry was no doubt astounding to himself as it was grateful to the thousands who hung enthralled on his thrilling utterances. Converted in 1769 in his nineteenth year, we find two years later, when Gov. Tryon was ravaging the country of the conquered Regulators, a new preacher appeared down in ancient Albemarle. It was only two years later when he was called to the pastorate of Bertie or Sandy Run church. This was then the most influential body of Baptists in eastern Carolina, and for so young a man to become their guide in religion was no small tribute to the unusual gifts of the young pastor. But this was only a foretaste of what the power and influence of Mr. Burkitt would soon be.

In order that the average reader may understand Mr. Burkitt's relations to the Baptists of Albemarle in that great era of change and reformation in religious and political affairs, it will be necessary to recur to the condition of the churches of his faith in the eastern and western settlements. When in

1773 Lemuel Burkitt became the pastor of Sandy Run church, there had never been exchanged the slightest token of fraternal recognition between the reformed churches of Sandy Creek Association and their Baptist brethren in the low country. Eight years of marvelous growth and expansion had been vouchsafed of heaven to the little group of the New Lights who formed the first congregation planted in 1755 by Messrs Stearns and Marshall. But a strange and unreasoning jealousy had been manifested by the older Baptist preachers and congregations toward these apostles of a purer faith. The same aversion to all change which is yet so largely characteristic of North Carolinians had condemned unheard every overture from the New Light missionaries. These old Baptists of the remote past were as unreasoning and deaf to the truth as have been the misguided Kehukees of a later period. The truth is, that the people were misguided by weak and uninformed preachers, who had failed to comprehend the logic of the situation and the force of the truth through the fact that they were unprepared to part with their prejudices.

Bishop Burkitt, young as he was, had suffered from no such unchristian disability. He loved the truth wherever he found it, and the truth had made him free. In the might of his victorious zeal and eloquence, he traversed the broad territory then holding the eastern Baptist churches and as one inspired he laid bare all the ruinous inconsistencies of the faith and practice which was keeping his beloved people in error and disunited from their wiser brethren. He told them that Baptists for centuries had warred upon infant baptism because Christ had required faith and repentance as prerequisites to such an ordinance. Here were Baptist churches not only baptizing men and women into membership, but in more instances than was at all creditable, they were ordaining ministers to the work of the full gospel ministry who made no pretence that they had any experience of the new birth in Christ. Was the Saviour's declarations to Nicodemus to be set down as meaning nothing, or were the Baptists claiming the old papal power of changing the Master's teaching? Was it no longer true that the Bible was the great Baptist rule of faith? Had the churches set up some higher standard of construction as to the plainest teachings of the Scriptures? The young apostle of the truth, with all his superiority of eloquence and equipment, was also consum-

* *Annales d*

† *Annales de Chimie*, lxviii. 88; or Nicholson's Journal, xxv. 155.

mate in his bearing and treatment of his less gifted brethren. Nothing more clearly demonstrated his greatness of soul than the fact that while thus exposing the ignorance and mistakes of his clerical peers, he was still enabled to retain their love and admiration for himself personally. A weaker and vainer reformer would have only succeeded in arraying every one of them in stubborn and unheeding opposition to the proposed purification of the churches. So far from this being the case when the ablest man among them, the Rev. Henry Abbott, pastor of the Camden church, had heard all the glowing and unanswerable appeal, he set the needed example of resigning his place as pastor until he could be again baptized. He had gone into the church, like a host of others, with no pretence of being converted. Being the son of the canon of Westminster in London, he had taken as true the teachings of his childhood touching baptismal regeneration.

Thus, like another Peter the Hermit, preaching a fresh crusade, Mr. Burkitt fixed and prepared the minds and hearts of the Albemarle Baptists for his next step in the program of reformation. The Sandy Run church in 1774 was the instrument for its consummation. It resolved in conference that in the future that body would hold fellowship with no congregation that would admit or continue in membership any person who had not claimed to have experienced such a change of heart as is implied in the Saviour's words touching the new birth. This apparently bold and high-handed position as to her relations to the other churches of the Kehukee Association was the occasion of, as Mr. Burkitt had foreseen, a no small outcry and stir among the dry bones in some of the churches in the region which, in later years, were to revolt from Bible teaching as to missions. There was little or no discord and disunion in the churches which later formed the Chowan Association, but beyond the Roanoke there were heard rumors of discontent and remonstrance over the course pursued at Sandy Run.

Not only had the visit of the Rev. Messrs. Vanhorn and Miller failed to affect these churches, it was feared by a multitude of anxious brethren that the action of Mr. Burkitt's church would be no more successful. They feared that so far from any general reform being thus brought about, that the only result would be a lasting and hopeless schism in the churches so lately unified in their formation of the Kehukee Association. That organization effected at the cost of so much labor, prayer and tears, they

ACETATE OF BARYTES is a crystallizable salt, which does not

said was now doomed to certain division and moral wreck. It really seemed that these prophets of evil were right in their horoscope of the future. Tidings from the upper counties were full of the resolutions of divers Baptist churches, who were instructing their delegations to the approaching session of the Kehukee Association at the Falls of Tar river, and nearly all of these were in the plainest sort of way condemnatory of Sandy Run's action.

But the patient and trusting soul of Lemuel Burkitt was all unmoved at the prospect of his brethren's inanity. He was at work for God and his people, and no human displeasure could reach or dismay a soul thus doubly armed in the course of duty. As the clerk of this same great Baptist Association, he had won so much love and admiration from all his brethren, it was sad to think that any part of the loving communion of the past should be lost by his efforts for the Lord. His sensitive and poetic soul instinctively shrank from everything like feud and bitterness, but he recalled the fact of how his Lord and Master, with all his gentleness and beneficence, had yet found life so little a bed of roses; so let the worst come that was possible to the promptings of prejudice and unreasoning prepossessions, the pathway of his duty was still left as plain and undisturbed as the light of the stars.

On the other hand, there were many things to sustain the young reformer and his faithful Sandy Run congregation in their high and devoted course. Elder John Meglamre, the moderator of the Kehukee Association, was the first to come to his rescue. His Sussex church in Virginia passed resolutions in conference precisely similar to those of the Bertie people. Then came news of similar action of the churches both in Virginia and North Carolina, but the great majority had as yet been averse or silent on the issue. Before the month of October could come and witness the marshalling of the Baptist hosts in the discussion of their differences, the shots had been fired by the British soldiers at Lexington, whose echoes rolled around the world. Loving hearts already sore at the prospect of discord with brethren, saw with added dismay their native land forced into conflict with their King, who was preparing great fleets and armies for their subjugation to his wishes. It can, then, be easily imagined how anxious and prayerful the soul of Lemuel Burkitt must have grown as discord and danger, both in

Church and State, projected their ominous shadows around him. With his dauntless and patriotic countrymen, he only drew nearer to God as the night of death and uncertainty deepened around him. To follow on in the road of duty and right might bring him sorrow and the loss of all things worldly, but there yet remained, like hope in Pandora's box, the consolation and support of his soul at ease with God and himself.

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138° Fahrenheit. It is miscible in all proportions, with water, with alcohol, and with all the volatile oils, and, at a temperature considerably below its boiling point, with the fixed oils. When heated it dissolves sulphur and wax.

CHAPTER XXI.

ANIMAL SUBSTANCES.

THE products of vegetable and of animal life, though they agree frequently in external characters, and even in some of their chemical relations, present several circumstances of distinction, which, in general, sufficiently discriminate the two classes. Animal substances are the results of still more delicate processes, and of a more refined organization; and the balance of affinities, by which they exist, is disturbed by still slighter causes. To the three great components of vegetable matter (oxygen, hydrogen, and carbon) a fourth is, in animal substances, added, and constitutes a large proportion of their structure. To the nitrogen, which they contain, are owing some of the most important qualities, that distinguish this class of compounds. Hence it is, that instead of passing through the vinous or acetous fermentations; they are peculiarly prone to undergo putrefaction; and that, during this change, they yield, among other products, both nitrogen gas and ammonia. When exposed to a high temperature, ammonia is, also, generated in great abundance, by their decomposition; little or no acetic acid is produced; and the coal, which remains, differs from vegetable charcoal, in being much less combustible. This general description, however, though it applies to most individuals of the animal kingdom, is not strictly true with respect to all. Animal jelly, for example, is rendered sour by spontaneous decomposition. A few vegetable substances, it may also be added, gluten for instance, become at once putrid; and furnish ammonia when decomposed by heat.

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

Memoir V—Rev. Lemuel Burkitt.

CHAPTER THREE.

The man who by the grace of God, his own native greatness and the accidents of fortune, is enabled to play successfully in the role of a reformer, is one of the noblest and most beneficent of human creatures. Though a thousand spurious pretenders and cranks have arisen in every age to bring obloquy and contempt on the nobler types, still the world will never cease to remember and reverence the wise and heroic spirits that have shown them the way to higher planes of thought and action. Suppose it were possible to strike off from the catalogue of mankind's social and religious privileges, those that resulted from the teaching and labors of Wickliffe, Luther, Jefferson and Gladstone, what a fearful outcry would ascend to heaven at the loss of so many things that make life worth living in this world! The miracles of human advancement wrought under the leadership of Moses were almost in every instance as directly the work of God as were those of our divine Lord and Saviour. To such complete revolutions in the affairs of mankind we would be impious to offer contrasts with those effected by the exertions of the greatest of our race. As heaven is high above earth, so far did they surpass the most comprehensive of merely human triumphs over the errors and abuses of preceding ages. While this is true, yet we should never forget or cease to reverence the great men who have so largely contributed toward making civilization what it now is. The church militant also has been in every age largely indebted to such holy and heroic spirits. While remembering our Lord's promise that the Holy Spirit should be ever present to aid and sustain his people, we at the same time know that chosen vessels in human form have been the means through which such protecting power has been exerted.

When in October of the ever memorable year of our Lord 1775, Elder Burkitt reached the scene of religious conflict, amid the delegations who had come to the Falls of Tar river were some noble coadjutors in the cause of reform. Chief among these in the

matter of personal influence was the venerable moderator, Rev. John McGlamre. This nobleman of nature as well as of grace was of Huguenot blood, and in the purity and beneficence of his life atoned for any want on his part of the larger mental gifts of his younger brother in the Lord, Mr. Burkitt. So loving and faithful had he been in his walk, that he had become more influential with many people than others of higher gifts as an orator and theologian. His position also as presiding officer in so numerous a body, through the last ten years, had given him not only weight in their councils as a trusted leader, but the added advantage that always can be afforded from the chair in matters it may please the presiding officer to favor.

But Mr. Burkitt's greatest assistant on this important occasion was found in the person of a layman, Col. William Horne then of Edgecombe, who was the grandfather of the late Hon. William Horne Battle, one of the Justices of our Supreme Court, and displayed great eloquence and no little skill in biblical criticism in his impassioned appeals for reform and unity in the creed and practice of the Baptist people. Col. Horne does not seem to have lingered long in the vicinity of the Falls of Tar river after this episode in his life, for we find him representing Bertie county in the lower house of the State Legislature in 1780, and for twenty years thereafter he was intrusted with the representation of that ancient and renowned constituency, sometimes in the Senate and then again in the House of Commons. It may have been that this very controversy in the Association inclined him to seek more congenial brethren further east. Elder Burkitt was further assisted in the debate by the Rev. David Barrow. He was a successor in holy orders to the late Mr. Sojourner in care of Baptist interests in Isle of Wight county in the State of Virginia. Mr. Barrow was, in some respects, a very considerable man in his day. Fluent and impassioned, he was ever impressive in his addresses to the multitude; but he lacked the power of analysis and arrangement, which were so manifest in Messrs. Burkitt and Martin Ross.

The church with which the Kehukee Association was then in session, was under the pastoral guidance of the Rev. John Moore. This rugged and indomitable, old conservation was a type and representative of the people, who so much admired and trusted him both in things spiritual and temporal.

His age, experience and strong will made him the most formidable of all the spirits that were then arrayed against the movement for greater spirituality in the Baptist churches. It was all in vain that Scripture and argument demonstrated the falsity of his premises. It was enough for him and the men he influenced, that the churches had managed to live in time past with their mixed herd of saints and sinners; and he was content, he said, to let well enough alone. He despised innovations. He denounced them as dangerous and sure of bringing on discord and schism. He was supported in such objections by Elders William Burgess of Toisnot and Charles Daniel of Kehukee and John Thomas. The debate between Messrs. Horne and Daniel was said to have been especially warm and exciting.

It was all in vain that Elder Burkitt and his allies called the attention of the body to the fact that in the confessions of faith adopted by all Baptist churches and the Kekukee Association, it was held that only upon a profession of faith in the Lord Jesus, could baptism be lawfully administered to any candidate—that any other baptism of unconverted men and women was opposed not only to Christ's commandments, but to the plain letter of our confessed creed on the subject. The result of the debate was a secession of the malcontents from the house where they had been in session and the institution of a rival body, which still laid claim to being the Kehukee Association. Reference has already been made to the fact that the Baptist churches which thus in those ancient days so obstinately clung to error were the same which just half a century later, after their surrender of this lunacy were to again go in eclipse far more hopeless and enduring, when in 1827 they revolted again against the truth and the light in their sinful and inexcusable warfare on missions. This singular instance of the power of heredity in transmitting spiritual and mental traits from one generation to others far removed in the line of descent has had its counterpart in the political history of our State. In the bloody troubles known in our history as the War of the Regulation, the very same counties that were singled out and scourged with fire and sword by Gov. Tryon were, exactly a century later, the very head-centre and chief arena of the Ku Klux Klan's operations. It would thus seem that certain races of men have as natural a bias to error and schism, as others toward a dauntless and irrepressible spirit of resistance to any interference with their civil rights and liberties.

Thus in his twenty-fifth year Lemuel Burkitt, by the help of God and his own great exertions at last had succeeded in breaking down the false barriers of pride and obstinacy which, for twenty years past, had arisen, as a great Chinese wall, dividing the hosts of Baptists in the Kehukee Association from all fellowship with those of other similar American organizations. He must have been saddened beyond measure when so many men he loved arose and went off from the great christian fold that he and they had so much delighted in building into grander dimensions. Like all men of high, natural genius, he was thereby more capable of grief and depression. He had succeeded in committing the Kehukee Association to what he knew in his soul was truth and true Baptist usage; but the grand organization was left wounded and maimed by the heroic treatment it was necessary to administer for its salvation. The dejected and defeated partizans of error had acknowledged that the reformers were the true representatives of the Kehukee Association by their revolt and secession. The residue of the faithful left with the old historic body were all the more valiant and effective from the fact that all discordant elements had thus voluntarily gone off to themselves. Men like Col. William Horne were seen leaving their homes to find congenial spirits in the reformed churches. Peace reigned in all the Baptist circles of old Albemarle; but a far different order of things arose in the seceding churches. The wiser preachers and laymen made their conferences stormy with their well-founded complaints of the fatal mistake made by their delegates at the late Association. The peace that had been dearer to Rev. John Moore than even the truth as it is in Jesus, utterly failed of its realization in the miserable issue he had done so much to bring about. Instead of peace flowing like a river around him, like the infatuated and mistaken Greek of old, he had but sown a crop of dragon's teeth to spring up and divide every church that followed his devices, until, ten years later, like repentant prodigals, they were to return to the fold of love and abundance.

Elder Burkitt had, like all his clerical brethren in the Kehukee Association, confined his duties as pastor to the single congregation in Bertie. The unfortunate habit of frittering away their usefulness on four or more different churches had not obtained

foothold in North Carolina or indeed anywhere else. This system, which the later eminent divine, the Rev. Dr. J. B. Jeter, used to denounce as "ecclesiastical polygamy," is one of those unscriptural innovations of later days. But while thus confining his relations to a single change, he was not the less abundant in labors. He made excursions in many fields that the light of the gospel had not yet illumined, and thus not even the Cumberland settlements of the future State of Tennessee and Kentucky were too distant for the missionary whose home was so close down by the waters of the Atlantic ocean. No railways were then in existence to bear along the Lord's messenger as with the rush of the cyclone. Not even a lumbering stage coach had yet been utilized to connect the men of the western frontiers with the civilization of the east. By means of the Watauga trail, first blazed out by Daniel Boone, he could reach the "dark and bloody ground," just south of the Ohio river, but so rugged was this highway of the early settlers, men generally made the journey on horseback. Such a journey undertaken by a traveller was as full of bodily perils as it was of the loneliness and hardship in locomotion. Prowling bands of Indians from the great prairies between the Mississippi and Ohio rivers were ever and anon gliding like phantoms through their former hunting grounds, to bear off to captivity and death every pale faced intruder they could find beyond the reach of the log-forts of the white settlements. Nor were the Indians of that day the only source of danger to such men as were unwary in their selection of lodging places, when the shades of coming night warned them to seek shelter for the wayfarer and his steed. Cutthroats and villains of the blackest dye not unfrequently erected cabins on the trail for the special purpose of murder and robbery of the misguided guests who listened to their treacherous offers of hospitality. Mr. Burkitt, no doubt, gave such terrors as this last but small consideration, for he well knew that men of his calling bore charmed lives in all such dens of guilt and blood. No murderer was so ignorant and stolid as to dream of finding money on the body of a peripatetic preacher. And besides this, there was some mysterious awe and consideration in the hearts of the vilest of the human race for such a man toiling on and being spent on his mission of love and mercy. Strange and almost miraculous tales were told of how some unseen influence would stay the uplifted hand or ward off the best directed

rifle-shots from the persons of the heroic heralds of the Cross. One such was said to have deliberately ventured into deadly peril to carry consolation to a dying sinner who asked for his presence. He thought he was alone in the stillness of the night, but assassins lying in wait for his return reported that a horseman rode on either side of their intended victim and thus frustrated their purpose.

parts have been ined from blood, by l pour- ing water upon

For the purp ents, Mr. Hatchett c uring 15 days, in wat e be- ing such as not to excite putrefaction. The shreds of muscle were then boiled for five hours every day, during three weeks, changing the water at each boiling; and, finally the residue was put into a press, and dried by the heat of a water bath.

Fibrin has the following characters.

1. It has a white colour, and is destitute of taste and smell. It is soft and elastic, and becomes of a deeper colour, on drying.

2. It undergoes no change, when exposed to the air in a moist state; nor is it altered by being kept under water.

3. When heated, it contracts, and moves like a slip of horn, exhaling at the same time a smell of burning feathers. Exposed to a stronger heat in close vessels, it yields water, carbonate of ammonia, a thick heavy fetid oil, and carbonic acid, and hydro-carburet gases.—It leaves a larger proportion of charcoal, than remains after the decomposition either of gelatine or albumen.

4. It is insoluble in water, except by the heat of a Papin's digestor, and also in alcohol, ether, and oils.

5. It is readily soluble in acids. Sulphuric acid dissolves it and acquires a deep-brown colour; charcoal is precipitated, and acetic acid is formed. Muriatic acid converts it into a green jelly. Acetic, citric, oxalic, and tartaric acids, dissolve it; and the solutions, when concentrated, assume the appearance of jelly.

6. From acid solutions, alkalis precipitate fibrin, in flakes, which are soluble in hot water, and which resemble gelatine in properties.

7. Diluted nitric acid separates a larger quantity of nitrogen gas from fibrin, than from any other animal substance. The dissolved portion, when concentrated by evaporation, and again dissolved in hot water, is precipitated by tan and nitro-muriate of tin, and possesses, therefore, the appropriate characters of gelatine. A larger digestion of fibrin in diluted nitric acid converts part of it into a kind of fatty matter, which swims on the surface. This concrete oil contains a considerable redundance of acid, from which it may be freed, by melting it, once or twice, in water. From the residuary nitric acid a proportion of oxalic acid may be separated by evaporation.

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CHAPTER FOUR.

The war of the Revolution was a great interruption and obstacle to many others of the godly laborers in the Lord's vineyard besides Elder Lemuel Burkitt. So direful grew the struggle in parts of North Carolina that even the pitiless soul of Col. Banastre Tarleton grew sick of such butchery as marked the forays of David Fannin, and declared in his memoirs of the period, that another year, such as 1781, would depopulate the State. While the Albemarle region was almost wholly exempt from such evils, still British outrages at Suffolk in Virginia were so close at hand that the alarm that was occasioned led to the suspension of the sessions of the Kehukee Association for several years. Many church-members of that fold were either in the Continental army, or they were enrolled under the standard of Gen. Gregory. It was during these stormy years of blood and confusion that a great bond of love and confidence was formed between Mr. Burkitt and Godwin Cotton. So close was this tie, the great preacher bought a farm alongside that of his friend and brother in the Lord. They were nearly the same age, and to both the cause of the Baptist people was paramount to all other human affairs. Not that either felt for a moment in any way indifferent to the freedom of America. On the contrary, their brightest hopes for the emancipation of their faith were bound up in the success of the revolted Colonies. With the overthrow of King George's control in America, they had much reason to believe there would come at the same time the downfall of the Church Establishments all over the Republic. Gen. Washington gave noble testimony to the united and zealous support given him in his seven years of perilous combat, and as the first President of the United States certified to the world how they had been alike strenuous as soldiers in the field and in yielding loyal and unquestioned fealty to the revolutionary officials in civil affairs.

When British violence and brutality toward the people of Suffolk and its vicinity had with other reasons resulted in the sus-

pension of the sessions of the Kehukee Association, the heart of Mr. Burkitt was widowed of many of its chiefest joys. He not only pined for the presence of so many to whom his soul was knitted. The valiant soldiers of the Lord, who were still waging a dubious conflict for emancipation in Virginia, as well against the ecclesiastical tyrants at home as the King beyond the seas, no longer met in annual conclave to concert measures with their Carolina allies. All his many plans for missionary concert of action among the preachers and the churches were in complete abeyance. To that reverend father in the Lord, Elder McGlamre as the Moderator, and to Mr. Burkitt as the Clerk, the Kehukee Association had committed authority to call another meeting whenever they should think such action prudent and proper. For some reason now unaccountable in its strangeness, the chapel of St. John in Hertford county was first selected as the place where the session should be held in October, 1782. Capt. Arthur Cotton, the father of Mr. Burkitt's peculiar friend, as one of the church wardens of old St. John's, had given his consent to the use of the Episcopal chapel, but just before the arrival of the delegations, Col. Robert Sumner, the other warden, made such violent objection to what he said would be a profanation of the ancient fane, Capt. Cotton invited the Baptist people to his own spacious brick residence. There under the shade of wide-spreading mulberry trees, arrangements had been made for the comfort of the delegates and visitors. The village of St. John's and the many farm-houses of Ahoskie Ridge gave ample entertainment to all the many good people who gathered there to rejoice over the renewal of old Kehukee's power and usefulness.

Just a year had gone by since along with all true Americans the Baptist people of the Kehukee churches first heard the glad tidings of Lord Cornwallis' overthrow at Yorktown. The ablest and most effective of all the British commanders had, after a noble career of victory, at last came to such entire defeat that the seven years of war were virtually ended. We can not in our day appreciate the feelings that actuated our forefathers on that occasion. In our plenitude of power and safety from all apprehensions of invasion from foreign nations, we fail to remember how feeble in comparison were the thin settlements strung along the Atlantic seaboard. With all the conjoined dangers of Indian and servile insurrection,

added to the bloody work of the British soldiers and Tories, the wonder is that men could be found brave enough to risk such an aggregation of perils. But the men who thus dared so much to be free, were not to be balked in the line of duty by any suggestion of evil to come. They had an unfaltering trust in the God of battles. They felt assured of that divine protection promised to all who, in the direst grief and danger, put their trust in the Lord. Had they been modern agnostics with their sneers and doubts, they would have prated about the maxims which tell us that God is neutral in such human complications, and that the sole arbitors of every conflict at arms are the heavier battalions and larger purse of those who may be so fortunate as find themselves possessed of such advantages.

The war had largely circumscribed, during its pendency, the area of Mr. Burkitt's activity as a missionary. With the return of peace, he put on a double portion of that wonderful activity that was so largely characteristic of the man in every portion of his career. Like his noble compeer in grace, Elder Silas Mercer of Halifax county, he was no longer to be circumscribed by State lines. No pent up Utica should longer confine his powers. Strange peoples and unknown lands were to be now visited and thrilled by his eloquent appeals. This same distinguished Baptist divine, the Rev. Silas Mercer, was present at the Association of 1782. He was one of the foremost preachers ever born in North Carolina, and the great crowds gathered beneath the spreading trees at Mulberry Grove were enraptured with his splendid discourse on Sunday.

Another of the foremost American Baptist preachers was seen and heard on the same occasion in the person of Elder Abraham Marshall of Georgia. He was the son of that Rev. Daniel Marshall whose life and services were commemorated in the preceding memoir. With broader culture and a more finished elocution, Mr. Marshall was even more powerful in the pulpit than his honored father in his palmiest days. But he or some one else brought great loss to North Carolina by inducing Mr. Mercer to leave our limits and make Georgia his future home.

With the return of peace to the American people, Mr. Burkitt was further cheered by the continued applications of the different revolted churches of old Kehukee, which had gone off on a tangent at the Falls of Tar river in 1775. Soon the vast christian brotherhood had with hooked shields again formed

their phalanx of old. But the body got to be so huge and unwieldy that in 1790 the Virginia churches withdrew and formed the Portsmouth Association. A year or two later the churches around Newbern followed this example in the formation of the Neuse Association. These movements curtailed the amount of Mr. Burkitt's labors as Clerk of the Kehukee Association, but the favor of his brethren soon more than restored the sum of his labors by making him the historian of the great Association he so much loved. We have only to read the chronicle he was thus induced to prepare and compare it with the rapid and jejune continuation by other hands, to see how remarkable a man he must have been. Confined by the directions of the committee who had the proposed history in charge to a mere skeleton of a narrative, he yet managed to store it with many incidents of movement and in his terse style was always abounding in pungent and pertinent observations. The little fragment, meagre as it is in size and detail, is still the only source from which we can recall the Baptist movements in eastern Virginia and North Carolina for the period embraced in its pages. Thus as leading preacher and man of affairs in the Kehukee Association, besides his great role as reformer, Mr. Burkitt had bargained out into still another great department of usefulness. It was thrice fortunate for his own fame and memory that he thus left his imperishable record; for great as he was without this book, we should have but a mutilated torso, instead of the full statue of the man. No doubt many traditions would have handed down to after generations dim glimpses of his power and usefulness, but at best these would have been vague and shadowy.

But Mr. Burkitt had great sorrow along with many of his brethren that the late war had so completely steeled the hearts of the people to any religious influences. It was all in vain that the most moving discourses were delivered in the hope of a revival of religion. It seemed, on the contrary, that French skepticism and atheism were poisoning and blighting the hopes of heaven over a large part of the new Federal Union. France had given such noble and timely aid to the suffering Colonies in their late struggle that great love and gratitude was felt by all the American people for their late gallant allies in the bloody struggle. This sentiment, so natural and honorable in itself, was used by French emissaries of the infidel

philosophers to debauch the minds and souls of the trusting American people. Alas! the task seemed but too easy when in place of the old trust in God doubt and blasphemy were heard all over the land in the little debating clubs which were organized to spread abroad this foreign contagion It was all in vain for Lemuel Burkitt to expect God's blessing on a people thus perverted and apparently undone. When the Associations met, there was only a meagre list of additions to the churches to be reported. He gives these reports for a number of years, and so small were they that the loss by death and dismission must have more than countervailed such small gains. The future of America seemed overcast with a hopeless gloom. Men of God were on every side depressed and with only one hope left. They never forgot that "Christ is able to save to the uttermost part of the world," and they trusted, in good reason, their hope would yet be realized.

At last came tidings from Tennessee and Kentucky that the Lord had visited his people. A great pentecostal season of refreshment and conviction flowed in upon the new countries like some mighty tidal wave of God's grace. The careless and skeptical multitudes came flocking by thousands and myriads to find the Lord they had learned to doubt and neglect. The great spiritual revival of 1801 and 1802 is yet one of the wonders of our history as a nation. From dead apathy and distrust of all things heavenly and pure, the same communities awoke to newness of life. From the Atlantic seacoast to the wilderness beyond the Mississippi, the great tide of grace rolled on, and America was saved from the foul embraces of a creed which had already deluged France in blood and ruin.

The glad tidings from the West filled the soul of Mr. Burkitt with such joy that he mounted his horse and set out for the theatre of such glorious blessings. How, as he went on his way, he found the great gatherings of men and women seeking the way to life; and how, through both of the new States, he thrilled so many thousands with the magic of his eloquence and zeal, is yet a household tradition in many a family whose ancestors found peace in his preaching and prayers. He had long prayed for the coming of the Holy Spirit in all his power, and lo! here was what surpassed and dwarfed his loftiest dreams. Thus in a continuous

* Philosophical Transactions, 1808.

† Philosophical Transactions, 1809.

round of abounding grace, Lemuel Burkitt lingered until, when duty called him home, he came back with a light in his face that had never been seen there before. He was like Moses when he descended from Sinai, the glory of the Lord had not yet ceased to illume his features.

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drogen of the blood; but this hypothesis is inconsistent with the experiments of Messrs. Allen and Pepys, which have traced the whole of the oxygen into combination with carbon. It is probably therefore nothing more than the condensed vapour of a portion of that fluid, which is ordinarily secreted into the bronchial cells.

An important purpose of the function of respiration is, that it contributes to that equable temperature, which the animal body preserves, amidst all the changes in the surrounding medium. This is peculiarly the property of living matter; for all other bodies have the same degree of heat with the substances that are in contact with them. In the human body, the temperature varies only a very few degrees from 96°, whether it be exposed to a cold of many degrees below the freezing point; or whether it be surrounded by an atmosphere, little short of the heat of boiling water. There must, then, be certain processes in the animal economy, by which, in the former case, caloric is reduced from a latent form to that of temperature; and, in the latter case, by which the great excess of caloric is absorbed, and prevented from becoming injurious by its accumulation.

Though we are ignorant of those precise differences, which constitute the distinction between venous and arterial blood, or in what way the function of respiration converts the former into the latter, yet a fact of considerable importance, on this subject, has been discovered by Dr. Crawford. The capacity of arterial blood for caloric he found to be superior to that of venous blood, in the proportion of 1030 to 892. When, therefore, arterial blood is converted into venous, a considerable quantity of caloric must pass from a latent to a free state, and must prove an abundant source of temperature. Now this is precisely what is constantly taking place in the body. Caloric is evolved by the combination of the inspired oxygen with carbon; but as the capacity of blood for caloric is, at the same tin·, enlarged, its temperature is not raised by being thus arterialized. In its progress through the system, the blood again suffers a diminution of capacity; and the caloric, which it had carried in a latent form to the remotest extremities, is extricated, and applied to the support of animal tem-

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

Memoir V—Rev. Lemuel Burkitt.

CHAPTER FIVE.

The treatment of historical subjects is largely subject to the same rules of treatment that regulate a painting illustrative of some event in the past. Thus we find the artist gives prominence of place in his grouping and the highest lights to the chief actors in the scene he depicts. On the same principle in our reproduction of the Baptist past in North Carolina, we must give Lemuel Burkitt all the space and position his unequalled services merited. It takes more space to tell the story of such a life because it was so much more frequent and abiding in its influence for good. He had brethren, no doubt, who were as zealous and faithful as he, but the measure of his deeds and achievements so far surpassed them all that comparisons would be simply odious. Indeed with the single exception of the great work of enlisting Baptist support in the cause of Foreign Missions and Education, he had left nothing to be added to the completeness of his work as a reformer. Nor was he to withhold his aid from those other steps for higher usefulness and consecration in the individuals and churches. He was to align himself alongside of Martin Ross, when that great preacher introduced his first memorable resolutions into the session of the Kehukee Association held in 1803, whereby they were exhorted to put themselves on the same level as had been lately witnessed among the Baptist people of Kettering in England. Dr Carey had gone on his way to seek the lost millions of British India, and Andrew Fuller was left to lead his people into a proper support of the new apostle to the Gentiles. American Baptists had manifested great interest in the salvation of their Indian neighbors, but that they owed any duty to heathen nations beyond the seas had never suggested itself to their minds. It required just such leaders as Ross and Burkitt to bring on so great proposals. Of course the old conservatives were there in force to protest against the Lord's work, simply because they and their fathers had not found it their duty to help in the conversion of the heathen

millions. But with two such champions of missions to thunder forth the defence of the work they had embraced, the smaller natures were either abashed or so silenced, that a proper circular was framed and sent out to the churches urging them to go forward in the work of the Lord.

It was remarked at the conclusion of the last chapter that Mr. Burkitt came back from his recent participation in the great revival in the West in 1801 as one who had been freshly inspired and magnified in his office as God's ambassador to perishing men. Never before had his voice such wondrous power on listening multitudes. It seemed that some wonderful spiritual magnetism flowed out from his person and prostrated the hardest-hearted and most unbelieving of sinners. Vast crowds were in tumult of a varying emotion as the great preacher waxed ever more impressive and resistless in his pictures of the terrors awaiting the unrepentant death-bed. With equal force, but in the most melting appeals, the safety and beatitude of those who trust in Christ's atonement was presented as the wise alternative. His first meeting with his Baptist people on his return was at the Kehukee Association, held that year with the church at Great Swamp in Gates county. In a sermon he told of the wonders of God's grace he had witnessed in the West. How in eight months more than six thousand souls had been converted. and how the work was still widening and deepening as it extended over the settlements of the new States. The effect was profound in its immediate and consequent results upon the people attending the session.

Great revivals at once began in the surrounding churches, and the next year two thousand additions to the membership of the congregations were reported to the Association. As a specimen of the deep concern which had taken possession of the people's minds in relation to the salvation of their souls, a short and exceedingly modest account from the pen of Mr. Burkitt himself is herewith given. Says he:

"At a Union Meeting at Parker's (Meherrin) Meeting House in August, 1803, it was supposed there were four thousand people. The weather proved very rainy on Sunday. There was a stage erected in the meeting-house yard, and at about half after eleven o'clock Elder Burkitt ascended the stage to

preach, and it was expected from the appearance of the clouds it would rain every moment, and before he was done preaching it did so. Yet notwithstanding, the numerous congregation still kept together; and although every effort was used to shun the rain by umbrellas, carriages, blankets etc., yet we believe one thousand people were exposed to the rain without any shelter; and some crying, some convulsed on the ground, some begging the ministers to pray for them; and they composedly stood and received the falling shower without ever being dispersed."

This was in all truth a severe test upon Mr. Burkitt's powers in holding the attention of his congregation. Very rare have been the instances of such unusual influence over a mixed multitude. It proves conclusively that he was indeed a great orator. Yet those who heard him preach said that his voice was far from being strong and sonorous. He was of medium height, well-formed and active in his movements. So much was he loved and trusted by people of all creeds that in the State Convention called to meet in Hillsboro in 1788 to consider the propriety of adopting the new Federal Constitution, he with no solicitation on his part was chosen along with Maj. Samuel Harrell as a delegate to represent Hertford county. He had been so uniform in his support of the American cause and so firm in his adhesion to the ~~more~~ democratic views of Mr. Jefferson and his supporters, that it was safely left to his discretion to determine for his constituents as to what should be done in the premises.

With increasing years beginning to warn him of failing strength, Lemuel Burkitt, after his return from the revival in the West, only redoubled his previous zeal and labors for the Lord. Though not yet an old man so far as the lapse of years is concerned, he was yet sensibly feeling the results of ceaseless labor. The night was close at hand when a long rest would be his. He who giveth his beloved sleep had one more great work for the faithful servant, and then like Moses on Pisgah, all the weary load of toil and responsibility would forever be lost in the peace of God. The famous query touching the duty of the Baptist churches then constituting the Kehukee Association as to Foreign Missions had developed in the ensuing years plain proofs of a want of unity and homogeniety as between the congregations east and west of Roanoke river. While

the ascendency of Messrs. Burkitt and Martin Ross was too great for open opposition to a scheme of love they both so warmly advocated, yet there were such delays in action and such cold commendation from most of the churches lately returned from their temporary revolt, that the two great preachers, along with Hon. George Outlaw of Bertie, were convinced that if the Albemarle Baptist churches ever expected much christian growth and development, then it was time to sever all entangling ties with the torpid and lifeless crowd that only hung as an incubus on their best efforts to advance the cause of the Lord and his people.

Moving on this line, petitions were sent up from the Albemale churches to the Kehukee Association as it met in session at Meherrin in 1805 Then and there the great body, since known as the Chowan Association, had its origin. It was in the next year that the first session was held, and from that day to this the mighty results on the one hand wrought by the new body, and the schism, slow decay and total non-effectiveness of the other, show how wise and timely was the movement. If Burkitt and Ross had been gifted with such length of years as Methusaleh, and the leavening power of the Chowan churches had still in the clear vision of old by sheer force of higher zeal and faith kept this people from the ruin and downfall of 1827, it would have been accomplished at great cost. Not only would many a noble step taken in reaching a higher plane of usefulness been checked and retarded by the crowd who could see nothing good beyond what was practiced by their fathers, but the wear and tear of souls thus chained to a body of death would have realized something of the Apostle's torture when he cried out in his anguish as to who should deliver him from such tribulation. There is no curse greater to any christian sect than churches which are so lifeless and avaricious, that they were ever found as stumbling blocks in the way of others who are anxious to give themselves and their means to the Lord's cause. The human heart is never so cunning and remorseless as when framing excuses for withholding any bestowal of its hoarded treasures. Men who are apparently godly in other respects, find their shibboleth on such an occasion. With all their sighs, groans and loud prayers in public, they find it impossible to part with that accursed gold that has stolen their souls from the Master.

Elder Burkitt had planted a new church

at Potecasi, but it was not organized until the year after his death. He saw the Chowan Association move off on that noble and illustrious career which, under God's providence, has resulted in so many blessings to the Baptists of the whole State. He served as its Clerk for the two years he was spared to his people, but his long service in the same capacity in the old Kehukee made his soul still yearn for the presence and companionship of many that he loved very tenderly. It was thus that he missed no session of the venerable mother of so many Associations. The greetings were as warm as of old, and on Sunday the great crowds of people listened with a strange awe and delight to a preacher they had long thought the greatest in the world, and yet here he was aflame with a strange light in his eyes, and his voice thrilled with a burden it never bore before. Overflowing with the greatness of the issues at stake and the shortness of his time in this world, he would descend with streaming eyes from the pulpit, and, falling on his knees, he would beseech his hearers to be reconciled to God.

The premonition of coming death was one of the strangest incidents in the life of this extraordinary man. He was but fifty-seven years old and apparently in health, but the inner voice was repeating ever and anon, "Labor while it is yet day, for the night cometh wherein no man can labor." The event abundantly justified the correctness of these mysterious premonitions. He was preaching in July, 1807, when in the midst of his discourse he was seized by an ague. The end sure enough had come at last. They bore him in much love and tenderness to his humble home and were soon to bear him to his grave. Like Charles II., he never rallied from the fatal effects of those awful chills that slew so many thousands before the world and the doctors had learned the value of quinine.

Thus passed from the theatre of his usefulness a most richly and variously gifted man. In thirty years he had managed to bring about larger and more lasting improvements in the eastern Baptist people than all his predecessors had been able to accomplish in the century preceding. He was not one of those men who was great on a single line of human excellence. He was no more eloquent or successful in the pulpit than he was deep and accurate in his theological stores. With a strong bias to practical fancies, he could yet make as deep and subtle an analysis of any chain of reasoning as if the impassioned images of his vision never led to

such rapturous flights in his oratory. His greatest usefulness after all were the personal magnetism and tact that enabled him to win all hearts and then keep them in spite of the fact that he was so often brought in temporary antagonism with such friends as he pressed on his way as a reformer of abuses. It was seen and known that though only the Clerk of the Association, yet it was Lemuel Burkitt's will and schemes that were the rule of all the great christian body. Yet no one ever resented or denounced this powerful control exercised by a subordinate officer. It was accepted as a matter of course and the reformer was thus left to go on his way rejoicing. But these and all things else earthly were become things of the past when the Rev. Aaron Spivey as the preacher of the funeral sermon, and his sorrowing brethren far and near, gathered to bury his remains out of human sight. "A great man and a prince in Israel" had fallen in his armor. He had served long and nobly, and in dying had left not his like in all the land so abundantly blessed by his life and labors.

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matter cannot in this case exceed a few grains.

The curd of milk, when pressed, salted, and partly dried, composes cheese. In good cheese, however, there is always a large proportion of butter, which is enveloped in the curd, and is not afterwards easily separable. Curd, therefore, for exhibiting its chemical properties, should be prepared from milk, which has been deprived of cream, and should be made by the intervention of rennet. It is a white solid substance, insoluble in water and in alcohol, but readily soluble in pure alkalis, and precipitable therefrom by acids, though in a state more like tallow than the original curd. During solution in alkalis, a strong smell of ammonia is produced; and hence curd appears to be converted, by their action, into volatile alkali and fat. Liquid ammonia also dissolves curd; and it appears to be soluble by the pure alkaline earths. From the resemblance of its properties to those of the coagulated white of an egg, Scheele was induced to regard cheese as identical with albumen; and it is not improbable that if the curd could be obtained perfectly pure, their properties would exactly agree. By the combustion and calcination of curd, it appears, however, to afford a larger proportion of phosphate of lime and other saline substances, than is obtained from the coagulated white of an egg.

* Essays, p. 267. † Holland's Cheshire Report, p. 263.

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

MEMOIR VI—REV. MARTIN ROSS.

CHAPTER ONE.

"The kingdom of God cometh not with observation" was the declaration of our Lord. There were myriads of men in many different lands waiting and watching for the signs which were to disclose the advent of the long expected Messiah, yet the star of Bethlehem was an unheeded signal to all save the three wise men of the east and the humble shepherds of the Judæan plain. The Pharisee, set and rooted in the nest of his own preconceptions of the pomp and splendor necessarily attendant upon an event so august and potent in human affairs, disdained the thought that the King of the Jews could be identified with the puling baby, making his entrance upon life in the cattle stalls of a village inn. It was the same incredulity that led this sect thirty years later to mock at all the miracles of a Saviour who had been so long known as a village carpenter. A great feature in Christ's visit to this world seems to have been to mortify and banish from the hearts of his people all such vain and selfish expectations. We often find the true successors and representatives of these ancient self-deceivers in persons who have fixed up in their minds the way they will find release from their consciousness of sin and want of acceptance with God. Some expect to be converted by some manifestation from heaven almost as miraculous as that by which Saul of Tarsus was arrested on his bloody errand to Damascus. Others more reasonable await less significant manifestations on the part of the Holy Spirit, but with all their evident thirst for deliverance, we invariably find that such people are the last to be blest in the richest seasons of revival. But let us be thankful that not even stupidity and obstinacy are proof against the infinite mercy which sees and pities our poor human frailty. "If any man thirst let him come unto me and drink," cried the Lord Jesus to the listening multitudes, and so says he to-day even to men and women who would dictate the manner and style of their receiving pardon from the courts of heaven.

Such a line of thought was suggested by the life and conversion of Martin Ross, whose career in this world will form the subject of this memoir. A lad born in seclusion and comparative poverty amid the dense swamps which then fringed both banks of the Roanoke river, and then at the earliest moment of his fitness for military life going off to mingle in the carnage and confusion of contending armies, would appear to have slight prospect of usefulness in the future, so far as christian beneficence was concerned. His alternations of labor on his father's farm near Williamston, and then months of toil, exposure and evil connections amid the net fishermen of the Roanoke, were a poor school of morals at best, but counted as nothing when contrasted with the countless temptations and sinful examples encountered in armies so largely composed of French infidels and atheists. Yet a youth thus exposed to so many dangers of soul and body was, by the help of God, not only to survive the perils of the battle-field, but almost immediately on his return to his old home, he found the pearl of great price.

We have in the life of Rev. Reuben Ross, a brother of Martin, a vivid picture of the old Ross homestead and of life on the Roanake in those far off days. It seems that one William Ross had come as the first of the name, and made his home on the same farm near Williamston. He left a son, also named William, who was born Aug. 9th, 1731. Nine other boys and girls, beside Martin, made full the quiver of this pious and prolific old man, the second Wm. Ross. He was a member of Skewarkey Baptist church, and held with unquestioning faith all the extremest Calvinistic teachings and deductions on the subject of predestination. It would be amusing if so much that is tragic and ruinous did not mingle with the story, to tell to what lengths these well-meaning people carried their deductions of the fact that God has foreknowledge and control in human affairs. That men had at the same time been left in possession of their own wills in such matters, was as entirely ignored as if Christ had never taught the truth, that men are free to accept or reject his terms of mercy. With a fatalism that would astound even a Saracen dervish, these ultra Calvinists said it was "love's labor lost" to teach the way of life to their children. If they were of the true elect, then it was, they said, forestalling the work of the Holy Spirit to be thus attempting to save a

vessel perhaps consigned to eternal wrath from the foundation of the world. Thus beyond regular family worship there was scarcely a semblance of effort to mould and direct the moral growth of their own offspring. They were left to follow their own devices as to how they should spend Sundays It was a matter of small concern to old Mr. Ross, and men of his ilk, that his boys forgot that the Sabbath was not to be profaned. If they drank too much apple brandy on these Sunday frolics, it was set down as only an incident of youth and indiscretion which would be all forgiven when, in his own good time, God should call the prodigal from the error of his ways.

The Ross family lived just east of the town of Williamston on a farm then known as the "Islands." It was so situated that great advantages were obtained as to rearing and fattening live stock. William Ross found that the rich bottom lands of the Roanoke were a mine of wealth in their many sources of food for both hogs and neat cattle. The never failing supply of reed forage and the great crops of acorns and other kinds of mast sustained his cattle and hogs of themselves, and corn was only used to keep them gentle and mindful of human help. A low, rambling house built around a large central room, with a huge, wide spreading mulberry tree shading the front door, were the chief elements in the rural landscape containing the old Ross homestead. In that humble and unpretending home of simple, homely abundance were to be reared three ministers of the gospel. Two of them, Martin and Reuben Ross, were to attain great usefulness and influence in their separate fields of labor, while their brother James, in an humbler sphere, was to be no less zealous and useful. That so many of William Ross's sons thus became so useful in God's service, shows how much more pregnant and convincing is a pure and consistent christian's life than oceans of advice and admonition, wanting the proper sanctions of sincerity in the monitor. It is breath wasted for an inconsistent parent to talk morality to a boy who is aware of how such things fail to influence the life of him who thus essays to show the way to holiness. The father who dogmatizes and utters loud prayers all the week and still can not visit the stores on Saturday without getting fuddled with bad whiskey, rather disgusts than edifies the boys he would seek to influence for good. Old Mr. William Ross took just the opposite course. He walked close with God and let his example alone plead with the youths he loved and

yet only aided as to council, in his prayers made in their hearing, that God would yet in his own good time give them "the peace that passeth understanding."

Martin Ross no doubt pondered long and well over those weighty questions touching providence, free-will and that soul fatalism he saw overshadowing the life of his honored father. His strong, natural affections in earlier years might lead him to accept as true any gloss, however monstrous and incredible, that he got from William Ross; but that keen, undaunted intelligence that was in late years to make him immortal, early began to question many of the deductions made by the fatalists in their pretended amplification of Paul and Calvin's teaching on the subject. When in the stress of the Revolutionary war, Mr. Ross had sent Martin to join his two older brothers, John and William, on the tented field, the future orator and divine found a new school of lasting impressiveness. His ideas and emotions hitherto had been colored only by the hints he received at the old-field school and in the godly lives of his parents. In the army he found every day experiences showing the contrasts of strength and weakness in human character. He saw men grown to be veterans in the ranks who yet trembled and sought every means to avoid going into actual battle. On the other hand were a multitude that would be grieved and shamed if accident kept them back from the post of duty on such an occasion. He saw these same men freely volunteering to make up a forlorn hope, whenever their commander thought so bloody and dangerous a resort should be used against the insolent foe. He heard all shades of ecclesiastical teaching mooted and discussed around the winter camp fires and much to weaken his faith in Calvinistic fatalism. The Methodist chaplains and the reformed Baptists never grew weary in expatiating on the love and mercy of Christ for all our race. That his atonement was for all conditions and tribes, and that peace awaited every weary and heavy-laden soul that would really accept of Jesus. Such great Baptist preachers as John Gano, John Leland and Jeremiah Walker in their addresses to the troops preached a religion so much broader and more merciful than the iron-clad tenets Martin Ross had been hearing at Skewarkey, that his soul acquired a breadth of love and faith in the world-wide mercy of God that could never again cramp itself into the gloomy and hopeless fatalism of his parents.

When happily in 1781 the young soldier at

the age of nineteen years returned in peace and safety to his home on the Roanoke, both his own soul and those of the family went out in gratitude to that protecting providence which had not only shielded him from death in battle, but had brought him back without wounds or any of the diseases that wreck so many strong men in camp and hospital. He had not as yet made any open profession of religion, but the matter was not to be much longer deferred. Before the year was out, he was baptized as a member of Skewarkey church. There, young as he was, the congregation were edified and astonished at the mingled grace and power of his modest and short addresses in conference. He soon yielded to his impressions of duty and requested the church to give him license to preach the gospel. They not only did this, but at an astonishingly early period in his life and ministry called him as their pastor.

In the thick veil of oblivion which has forever hidden away from all human knowledge so much of the lives and transactions of even of the greatest men in North Carolina, we have lost all the details of how Martin Ross, under so many disadvantages, yet made himself the great preacher of after years. We are left to imagine how the strong native intelligence was alternately exalted and then grew almost desperate in his struggles for more light. It was vain to seek aid of the illiterate brethren he met in Union Meetings; they could not venture in exegesis beyond the plainest of beaten paths in their limited field of Bible construction. Some had read Dr. Gill's opinions on some of the deep things in Scripture, but as a rule not even so great a Baptist authority as the eminent English commentator was known to men who set themselves up as the spiritual guides of a people almost perishing for want of higher light and knowledge. Such perfunctory guidance of his people could not for a moment satisfy the conscience of Martin Ross. His clear, unclouded vision saw all the defects in himself and his older brethren who were trying to break the bread of life to the still more ignorant people. With great wrestling in prayer and close study of every literary aid in his reach, the rich natural endowments soon began to show increased lustre as the result. A wonderful young preacher, they said one and all, as the speaker warmed up into enthusiasm in the progress of his discourse. A flowing and yet severely logical style of preaching was the charm that delighted, and at the same

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time convinced such multitudes of their spiritual needs. It was an elocution that grew more finished and powerful as the orator waxed greater in knowledge and experience. And thus he went on from one degree of grace and strength unto another until all eastern Carolina was ringing with his praises.

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A diluted solution of potash dissolved hair, excepting a little oil, sulphur, and iron; and the compound was a sort of soap. The oil, if red hair was employed, had a yellow tinge. Alcohol, also, extracted from hair a portion of oil, the colour of which varied with that of the hair.

The coal, obtained by incinerating hair, afforded phosphate, sulphate, and carbonate of lime, muriate of soda, silex, magnesia, and oxides of iron and manganese. The whole of these substances bore a very small proportion to the hair, and varied in hair of different colours. Hair, therefore, appears to consist chiefly of an animal matter resembling coagulated albumen; of an oil of various colours; of sulphur, silex, carbonate and phosphate of lime; and oxides of iron and manganese.

Feathers probably agree in composition with hair. The quill, Mr. Hatchett has shown, consists of coagulated albumen without any gelatine.

The composition of *wool* is not accurately known; but from its forming a soap with pure alkalis, it probably consists of coagulated albumen.

We are equally ignorant of the true nature of silk. It is insoluble both in water and in alcohol, but dissolves in pure alkalis and acids. By the action of nitric acid it affords the peculiar substance already described under the name of the bitter principle.

SECTION IX.

Of the Substance of the Brain.

THE medullary matter of the brain and nervous system appears to differ from all other organized substances. It was first examined by M. Thouret, with a view to explain why the brain was exempted from the change, observed in the bodies which were interred in the *Cimetière des Innocens.* Fourcroy afterwards added many important facts, and corrected M. Thouret in several particulars.

The medullary substance of the brain is of a soft consistence,

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MEMOIR VI—REV. MARTIN ROSS.

CHAPTER TWO.

The Rev. Martin Ross did not at once leap into that leadership and control of religious affairs, as was seen in his great friend and cotemporary, Lemuel Burkitt. His early opportunity for social and literary culture had been inferior to that youth's, reared in the superior wealth and refinement of Chowan county. It was thus several years after Martin Ross had begun his career as a minister of the gospel before we find any mention of him in the history of the Kehukee Association. But this modest and proper delay on his part in assuming a leading part among the preachers and laymen of so great a body only enhanced his power, when after years of patient observation and preparation he made known the mighty resources of his mind and soul in the great Baptist conclave. Burkitt saw with much delight that here was a debater as skilful as himself in all the resources of synthetic and analytic treatment of the most exalted and abstruse problems of theology. He further recognized in the flowing and magnetic elocution, the sonorous tones, the pleading eyes and sympathetic bodily movements, elements of power that surpassed even his own resources in such respects. That another great religious orator had come to share his honors and influence gave the true man of God never a twinge of jealousy or uneasiness. He loved the cause to which he had devoted his life too deeply for any such sinful and unmanly feelings to find lodgment in his heart. He and Martin Ross, on the contrary, became loving yokefellows in the same great lines of development and progress for the Baptist people. In all the efforts for advance and higher living among the Lord's people these two were ever found with interlocking shields pressing resistlessly on against the advocates of discord and delay. Mr. Ross, like other Baptist preachers of his day and generation, was largely given to making preaching excursions in the different outlying sections of country, that were still near enough to enable him to reach home in time

for his regular appointments at Skewarkey. Some of these trips were doubly blessed. Both the missionary and the people were the better for his visitations. To the comparatively rich and cultured denizens of the counties lying between Chowan river and the Atlantic, Martin Ross seemed a gift from heaven. They always heard him gladly, and hundreds found the pearl of great price under his ministry. Many of the wealthiest and exclusive families that had looked with disdain on Baptist preachers and their doctrines were at last seen humbling themselves before the Lord and casting their future lots with their despised neighbors.

In such a community Mr. Ross found that the Baptists were quite a different people from the gloomy and iron-clad fatalists he was vainly seeking to lead into a more loving and gracious estimate of their Creator. While fully agreeing with the old Baptist tenet as to predestination as a necessary part of God's foreknowledge, he yet remembered the fulness of our Lord's offers of mercy to every one who would come and drink of the waters of life. He could not set down as unmeaning so many of those gracious and unlimited offers of the Master, simply because the Apostle Paul, in the course of his argument, had asserted that God, from the beginning of the world, had foreseen who would be saved. It seems a monstrous perversion of the whole tenor of our Saviour's career of loving benefactions and continual forgiveness of injuries and sins, that he should in advance decree the damnation of the least of his creatures. But it was all in vain that Martin Ross reminded his Skewarkey people of the fact that free will was left to every human creature, and it was thus the fault of the negligent and not that of God that men found no mercy at his hands. This church, with those at Kehukee and the Falls of Tar River, were the centres of the baleful hyper-Calvinistic fatalism. They rolled this doctrine as a sweet morsel under their tongues, and felt much of the old Pharisee sentiment of contempt for all who were not numbered among the elect of God.

It must have been a painful task for Mr. Ross to sunder his pastoral ties with the people he had known from infancy, and who had bestowed on him so many touching marks of their love and confidence. He had found peace and been baptized in this very fold. These people had been swift to perceive and encourage his gifts as a young preacher. His stern but faithful father had

died in the same fold in 1801. But with all these things to sadden him, Martin Ross felt in his soul that his work was to lie elsewhere in the future. Influences beyond his or any other human sagacity had tied up and circumscribed his influence in such a way at Skewarkey that he was forced to the conclusion that some new man should take the place he held. It was thus that the great preacher at last freed himself of the last incumbrance upon his soaring spirit. Passing over the broad waters that divided old Albemarle from the more western settlements, he went to the church at Yeoppim. It was almost like entering upon a new and higher stage of existence. The strong man in all his genius and power felt how much stronger he grew with a multitude of sympathetic souls sharing in his glorious aspirations for a day of better things among the Baptist people.

Burkitt and his allies had done great things for the churches, but there was still pressing need for advance along other lines. Not a letter or a delegate had ever been seen at the Kehukee from Sandy Creek or any of the Associations that once formed a part of her constituency. There was not even the semblance of fraternity, much less any concert of action, between the great bodies of Baptists thus enrolled in separate and almost hostile camps. With that keen, natural sagacity, which was one of Martin Ross's leading features of mind, he selected the recent extension of missionary work to foreign fields as the lever to lift the discordant divisions of his people into unity and fellowship, though all christendom was ringing with conflicting comments upon the great work undertaken by Dr. William Carey. Though a great impulse was pervading myriads of christian souls in different lands, as yet no man had gone from America to aid the brave and godly Englishman who, in despite of so many opposing influences, had yet begun the work of saving the souls of men and women "sitting in the region and shadow of death." While all Baptist traditions and records showed how, in spite of the most cruel and bloody laws to the contrary, the old preachers had passed from land to land, and though often imprisoned and burnt at the stake, these heralds of the Cross were still found faithfully prosecuting the work. In America there were not only the heathen Indians but many outlying settlements in the wilderness to tax the best energies and resources of a poor people in the work of their evangelization. As so much was yet to be done at home in America, the

other dusky and almond-eyed races swarming on the opposite side of the world, had not entered at all in the matter of their convictions of duty. But the Lord was opening the eyes and hearts of his people to the fact of the universal brotherhood of mankind, and Martin Ross was the first man in North Carolina to urge upon his people their duty in helping to send the gospel even to the far-off Asiatic multitudes.

It was thus that we find in the session of the Kehukee Association in 1803 that the matter was brought to an open issue by the following query offered by the Rev. Martin Ross, "Is not the Kehukee Association, with all her numerous and respectable friends, called on in Providence, in some way to step forward in support of that missionary spirit which the great God is so wonderfully reviving amongst the different denominations of good men in various parts of the world?" Let it be remembered that Martin Ross, born and reared in the darkest haunts of fatalism, was yet the man to take such ground nine years before Judson and Rice had started to India. Of course, so important and exciting a matter was bound, under all the rules and precedents of old Kehukee, to undergo many ordeals before reaching anything like approval from the Association. Mr. Moderator, the Rev. Jesse Read, referred the whole matter to a very select committee, including the leading ministers of the body, with instructions to report at the next annual meeting their impressions on the subject.

This was the beginning of a great work in Baptist circles in North Carolina. Its first effect was a prodigious stirring up of the dry bones in the congregations beyond the Roanoke. Here was another step in advance proposed as to the Lord's work, and that was enough to set all the old-fashioned conservatives in solid opposition. The Association, held at Meherrin in 1804, not only answered the query in the affirmative, but appointed delegates to meet others invited from Portsmouth and Neuse Associations at Cashie church in Bertie. There was inaugurated the movement which, long afterwards, resulted in the formation of the North Carolina Baptist State Convention. As was eminently proper, Mr. Ross was chosen to preach the introductory sermon at the Cashie Convention.

This memorable body convened on the third Sunday in June, 1805, and Revs. Lemuel Burkitt, Martin Ross, Aaron Spivey, Jesse Read and John McCabe were Kehukee's representatives on the occasion. The Convention proceeded to formulate plans for

the establishment of regular contributions for Home and Foreign Missions, but made no formal report to the Kehukee Association of the results of their labors. This grew out of the fact that when the year 1806 came, the Chowan Association had been formed, and to this far more sympathetic organization the leaders in the work belonged. Elder Biggs, in his continuation of Burkitt's history, says no report ever reached old Kehukee. This may be true, but we yet know her churches sent up funds repeatedly for missionary purposes to the General Meeting of Correspondence, year after year, until their final adumbration in 1827.

The debate in the old historic church at Meherrin must have been one of the most inspiring ever heard in this country. With Ross, Burkitt and George Outlaw to uphold the cause of missions was to insure a glowing and exhaustive presentation of the reasons that had led to the introduction of the query. It is not astonishing that with such advocates the stolid and inert tide waiters on the other side of the question should have but little to say. They were in fact, as a class, men of very few words on any occasion. If they could be induced to listen to argument and entreaty, it was to very little purpose. To reason and Scripture, to eloquence and persuasion, they simply opposed the *vis inertiæ* of their moveless natures.

But whatever of grief Martin Ross may have felt in the want of sympathy of such people with things so dear and momentous to him, he was largely compensated in the spirit so opposite to all this, evinced by the churches of the new Chowan Association. Unanimity and enthusiasm were accompaniments of every appeal to their souls for longer interest in the extension of Christ's kingdom of this world. The zeal and devotion which have all along marked and ennobled the record of this great christian body, led the people to accept the plain letter of our Lord's latest command without ever a doubt as to their duty in the premises. Christ had told his people assembled on Mount Olivet to witness his ascension, that beginning at Jerusalem they should preach the gospel to all nations. Mr. Ross had only aroused and fastened their attention on a plain matter of duty. Like Carey and Fuller in England, the preachers even had to be reasoned with before seeing the full weight of fealty they owed in the matter. The torpor and forgetfulness of God's people in this great responsibility they owed the heathen was passing away like a nightmare of the past, and nations were making ready to be-

gin the new crusade against the stocks and stones of the swarming millions of the far-off East. The car of Juggernaut might still roll on in its deadly course over the crushed bodies of his dupes, but the days of such fatal delusions were numbered. Deliverance long delayed was coming at last.

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plate, immersed in a solution of sulphate of copper, soon acquires a coat of this metal; and the same in other similar examples.

XI.—*Sulphate of Iron.*

This is the only one of the sulphates, except that of silver, applicable to the purposes of a test. When used with this view, it is generally employed for ascertaining the presence of oxygen gas, of which a natural water may contain a small quantity.

A water, suspected to contain this gas, may be mixed with a little recently-dissolved sulphate of iron, and kept corked up, in a phial completely filled by the mixture. If an oxide of iron be precipitated in the course of a few days, the water may be inferred to contain oxygen gas.

XII.—*Sulphate, Nitrate, and Acetate of Silver.*

These solutions are all in some measure applicable to similar purposes.

1. They are peculiarly adapted to the discovery of muriatic acid and of muriates. For the silver, quitting its solvent, combines with the muriatic acid, and forms a flaky precipitate, which, at first, is white, but, on exposure to the sun's light, acquires a blueish, and finally a black colour. This precipitate, dried and fused by a gentle heat, Dr. Black states to contain, in 1000 parts, as much muriatic acid as would form 425½ of crystallized muriate of soda, which estimate scarcely differs at all from that of Klaproth. The same quantity of muriate of silver (1000 parts) indicates, according to Kirwan, 454¾ of muriate of potash. Dr. Marcet's experiments and my own indicate a larger product of muriate of silver from the decomposition of dry muriate of soda, *viz.* not less than 240 grains from 100 of common salt. Hence 100 grains of fused muriate of silver denote 41.6 of muriate of soda, and about 19 grains of muriatic acid. A precipitation, however, may arise from other causes, which it may be proper to state.

2. The solutions of silver in acids are precipitated by carbonated alkalis and earths. The agency of the alkalis and earths may, however, be prevented, by previously saturating them with a few drops of the same acid in which the silver is dissolved.

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

MEMOIR VI—REV. MARTIN ROSS.

CHAPTER THREE.

The soul of Rev. Martin Ross must have been overflowed with thankfulness as he witnessed the growing usefulness and zeal of the new Chowan Association. This christian organization, which at once became the pride and hope of the whole denomination in North Carolina, exhibited so many signs of sympathy and support of the plans Mr. Ross was formulating for greater unity in the Lord's work, that like one of old, he "thanked God and took courage." But in the mysteries of providential ruling in the affairs of this world, a great loss and sorrow was close at hand. Just as the full blessedness of the work he and Burkitt had accomplished was made plain to the meanest capacities, the great preacher, who had done so much to aid him in his plans, sickened and died. It was like David, heart-broken over the fatal tidings from Gilboa, when Martin Ross fully comprehended that his chief brother in the Lord and hearty co-worker in all good things was sure enough dead and at the end of all his many labors. It was indeed a cruel and inexplicable loss to the surviving partner in the Lord's work. He was hardly weak enough to do, as so many others in similar circumstances have done, in his sorrow and confusion suffer doubts and resentment to overcloud the clearness of his trust and faith in the goodness of God. Such men are only staggered in their perception of the wasted plans and hopes crushed in such calamities. As they realize how well even the greatest of men can be spared from the teeming millions of earth, the old faith and confidence replace the shadows of doubt and sorrow, and the future plans are rearranged.

It was so with Mr. Ross. God had taken his chief helper and friend, but a multitude of less effective and loving assistants were left to do what they could to supply the loss. His brother, Rev. Reuben Ross, had also grown into fame and usefulness as a preacher. He was to become a great light unto the regions north of Nashville, Tenn., and in the southern parts of middle Kentucky. He, too, turned from the extreme Calvinistic features of the Skewarkey creed and was

heard proclaiming the same great doctrines of love and hope for the human race that illustrated the discourses of his elder brother. The old homestead in the Islands had been forsaken years before by John and William Ross and they were living also in the great West. Another brother, Rev. James Ross, went over into Bertie and planted the church which still bears his name. The old life of alternate labors on the farm and then of exciting weeks, as the young men captured the year's supplies of shad and herring from their nets in Roanoke river, still went on as when Martin was a boy and no great wars had called him to the tented field. The village of Williamston with its single straggling street and the Skewarkey church were both as sleepy and lifeless as ever; but Martin Ross was in the thick of a battle that excited his soul and mind as much as did the thunder of the guns at Yorktown and Eutaw Springs.

With a mind that delighted in system and organization, he was stretching all of his great powers, mental and physical, to the task of triumphing over the inertness and often mistaken conservatism of Baptist brethren all over the State. He saw what a power for good was already created in the Chowan Association; what limits could be set to a similar body embracing the organized Baptist hosts of the entire State? His dreams were not confined to a simple embodiment of the churches for promotion of missions. He longed for more light to the preachers and the people. No man better appreciated the blessings of education. He knew that ignorance had been the handmaid of superstition in all ages of the world's history. Though Wake Forest College was to be for many years still a thing of the future and no positive efforts were made for its establishment, still in the labors of the Rev. Luther Rice in building up Columbian College at Washington City, Mr. Ross saw the beginning of the end for which he prayed.

As the years went by and tidings came of the wonders Adoniram Judson was bringing about with God's help in Burmah, the earliest of his North Carolina supporters felt his soul lifted up with joy and thankfulness. When in 1803 he had dared to set this ball in motion, he was almost alone in his faith in such things; now great societies of many differing creeds, in widely-scattered nationalities, were contending in noble emulation as to which should do most for the salvation of the dusky races. Even the cold worldli-

ness of the rulers of the British East India Company was relaxing under the blessed results they saw effected by Dr. Carey and his successors in that field of labor. Instead of jealous and hostile criticism from the reviews and newspapers, the press was true to its great work of education and enlightenment, and thus warm words of commendation were seen replacing the late diatribes of such men as the Rev. Sidney Smith. The home governments were no less changed. They were no longer alarmed at and opposed to the whole system; they ceased to leave the missionaries to the tender mercies of any native king or other petty ruler who should see fit to murder or imprison the daring men who came on their way in despite of his threats. The missionaries, on the contrary, were recognized as entitled to all the protection their citizenship might indicate, and the native rulers soon learned that these strange visitors were not to be harmed without a due penalty for such an outrage.

We have in this memoir dwelt more on Mr. Ross's labors and triumphs as an organizer and reformer in ecclesiastical relations than on his extraordinary gifts and graces as an evangelist. Like his lost compeer, Mr. Burkitt, he was so eminent in both respects, that it is hard to say in which particular department of usefulness he was greater or more successful. As a preacher, he was unmatched in all those thronging years of marvelous growth and advancement generally, which marked the first two decades in the history of the Chowan Association. In his comprehensive and exhaustive treatment of religious topics in the pulpit, there was something to be heard that reached the consciences of all his audience. Pride, prejudice and frivolity were arrested and so held up to the introspection of men and women concerned, that the last subterfuge and evasion were swept from their possession, and like Adam and Eve after their sin in Paradise, such sinners became fully aware of their shame and peril. He was the first Baptist preacher in our State to make heavy inroads upon the Episcopal and wealthy classes. Pride and social exclusiveness had almost barred access of Baptist truth to such hearts until attracted by the outcry of Martin Ross; these people ventured out to be amused, and in many cases went home happily converted to God, and for the rest of their lives became humble and useful members of Baptist churches. Such people were by no means rare in the beautiful peninsulas that lie north of Albemarle sound. The

Harveys, Swanns, Porters, Skinners, Bakers, Blounts and others were rich enough to educate their sons at the great English universities and to deck their daughters in all the finery of the period. It was among such families that men like Mr. Thomas Brownrigg were won as jewels to shine in the Baptist coronet.

It was in this way that Mr. Ross planted that noble church in Perquimans county since known and honored as Bethel. He had been serving Yeopim as pastor up to this year of our Lord 1806, but from this time until his death twenty-one years later, the new congregation was added to his responsibilities. Ballard's Bridge was never directly under his pastoral care, but still enjoyed the benefit of his frequent visits. He was indeed in virtue of his superior age and talents a real Baptist bishop, largely directing and controling their religious affairs in all the ancient domain known as Albemarle. It was like the loving oversight exercised by the Apostle to the Gentiles, who, in virtue of his part in the salvation of his people, claimed the privilege of advice and admonition in the Lord's work. To no council, consistory, synod or conference did he or Martin Ross look for his credentials in such relations. They both recognized and enforced the independence of the separate churches, while still claiming, as their fathers, in God the right to condemn all such sin and disorder as was found among the men and women of the churches at Corinth and Galatia.

The Rev. Martin Ross was given a lease of life just twenty years longer than had fallen to the lot of his compeer, Rev. Lemuel Burkitt. They were born about the same time and had so largely shared in the same plans and aspirations for their people, that their brotherhood in the Lord became a very close bond of union between these born leaders of men. As the new churches crowded in upon the Chowan Association, and that great body year by year became more permanent in its influence in North Carolina, the only grief left in Mr. Ross's soul was the inefficiency of the body known as the General Committee of Correspondence. This consisted of delegates sent up each year, who generally met in Raleigh and transacted the small business affairs entrusted to their control. It was an abortive attempt by men doing the best that could be attained out of the obstinate aversion to change, that as a rule marked all Baptist movements of that and earlier days. He saw how far short

this make-shift fell of what he had desired in his soul and was saddened at the failure. But this did not so becloud his judgment that despair of the future was his. He was laboring and hoping for years for the establishment of such a body as was seen in the town of Greenville for the first time in 1830. He was not spared to this world long enough to see and be happy in that great event, for he died in the year of our Lord 1827.

If he missed this realization of so many bright hopes in the past, Martin Ross was at least spared the grief and shame that filled the hearts of so many good people that year over the sad course pursued by the Kehukee Association. Since the formation of the Chowan Association and the death of Lemuel Burkitt, the Rev. Joshua Lawrence had been growing more and more powerful in his influence over these people. He saw and encouraged all the worst features of their fatalism and aversion to everything not sanctified by prescriptive Baptist usage. Instead of laboring to soften the asperities and gloom of such men and women, Joshua Lawrence added the venom of hatred and distrust of all others who dared in any way to differ from him and the people he thus misled. Under his influence the older ties of love and fraternity were all cast to the wind, and insults and open hostility were assumed as the proper treatment of those who had so lately also been members of the Kehukee Association. The most malignant and unfounded aspersions were spread broadcast over the country as to the creed and practices of the regular Baptists, while this ill-natured, little rump set themselves up as the only visible saints of the Lord then left in the world. Martin Ross or Lemuel Burkitt, had they been alive and visited again the Association, both of whom had rendered such great services to her in the past, would have received no more recognition than a horse-thief or a stray Jesuit. Mr. Joshua Lawrence completely succeeded in adding hatred and bad manners to the previous faults of his people, and must have enjoyed the charms of the Chinese wall thus erected against all outside influences. But Martin Ross was beyond the malice and machinations of all such spirits. After long and sore battle the veteran spent in the stress of such a conflict, at last rested from every ill and toil. He had not only been faithful in his day, he had risen so far superior to its general level that he entitled himself to a

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place in that short catalogue of men who have made whole communities wiser and better. "Surely the end of such a man is peace." But alas! "the strong staff and the beautiful rod were broken." The beauty and strength of Israel had fallen in her high places. The great preacher was in his grave and had not left his like in all our borders.

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remaining in solution, may be precipitated by carbonate of potash; heat being applied, to expel the excess of carbonic acid.

Magnesia and alumine may, also, be separated by succinate of soda, which precipitates the latter earth only. (See sect. 1, xvii. of the chapter on Mineral Waters.)

When the solution of magnesia, of alumine, or of both, contains a small proportion of iron, this may be separated from either or both of the earths by evaporating to dryness, calcining the residue, during one hour, in a low red-heat, and dissolving again in dilute nitric acid, which does not take up iron when thus oxidized.

(H) The insoluble residue (A) may contain alumine, silex, and oxides of metals, so highly charged with oxygen as to resist the action of nitric and muriatic acids.

(*a*) Add concentrated sulphuric acid, with a small quantity of potash, and evaporate the mixture to dryness, in the vessel described in the note, page 249. On the dry mass pour a fresh portion of the acid; boil again to dryness, and let this be done, repeatedly, three or four times. By this operation, the alumine will be converted into a sulphate of alumine and potash, which will be easily soluble in warm water; and, from the solution, crystals of alum will shoot on evaporation.* Let the sulphate of alumine be washed off, and the insoluble part be collected and dried. The alumine may be precipitated by carbonate of potash; washed, dried, and ignited; and its weight ascertained.

During the evaporation of a solution of alumine, which has been separated from silex, portions of the latter earth continue to fall, even to the last. (See Klaproth, vol. i. pages 66 and 75.) These must be collected, and washed with warm water; the collected earth added to the portion (*b*,) and the washings to the solution (*a*.)

Alumine may be separated from oxide of iron by a solution of pure potash.

From whatever acid alumine is precipitated by fixed alkali, it is apt to retain a small portion of the precipitant. To ascertain the

* Klaproth procured crystals of alum from one fourth of a grain of alumine. The quantity of alumine he estimates at one tenth the weight of the crystallized alum which is obtained.

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

MEMOIR VII—REV. JEREMIAH WALKER.

CHAPTER ONE.

When the young king, George III., made his late Scottish teacher the Earl of Bute and Prime Minister of the British Empire, many tide waiters hastened to do homage to the man who was thus shown to be so high in the monarch's trust and affections. Among others who thus sought to recommend themselves both to the king and his minister was the adroit and unscrupulous Gov. Tryon of North Carolina. That fair region now included in the counties of Warren and Franklin was formed into the county he and the General Assembly called Bute. But the name proved as evanescent as the power of the man whose patronymic it bore. The great Revolution came and with it the name of Bute disappeared from our map to make room for those of the statesman and the hero who are still preserved to human remembrance in the names of Franklin and Warren. It was in this favored region that in the year 1747 a man child was born who was to be widely known and honored of men. They called him Jeremiah Walker, but in such poverty and ignorance were his parents and neighbors that small hopes were entertained by even those who loved him best as a child, that anything beyond humble obscurity could ever be his lot in this life. But that obscure child amid the red hills of Warren was not to be chained down by either the accidents of birth or the stress of social environments. In the miserable system, or rather, absence of all system as to school facilities then seen in our country, the lad early evinced a passionate desire for acquaintance with books and letters. Turning aside from all the amusements so dear to the great majority of boys and girls, young Jeremiah Walker could be found, book in hand, whenever the stern requirements of labor on the farm did not compel his assistance. With the small start he managed to get at the hands of a strolling teacher, the dauntless and tireless orator of the future managed to continually augment his slender store of acquirements until long before his majority was attained, the country side was filled with the fame of his knowledge. He early became a member of

the Baptist church and in conference charmed all hearts with the ease and grace of his elocution.

As young Walker seemed deeply pious, it was no wonder that a people who rejoiced in such weak preachers as generally served our churches of that day should have leaped to the conclusion that here was a chosen vessel of the Lord. Of course, a young man who so far surpassed all they had ever heard in his utterances on sacred subjects and who also professed to feel that he was called or God to preach the gospel, was gladly welcomed into such holy and tender relations. It was thus while still in his ruddy youth, ere the beard and bronze of manhood had visited his cheeks, that young Mr. Walker was ordained and set apart to the full functions of the gospel ministry. In his marvelous success in such relations, it seemed that all the haste and precipitation of his exaltation were abundantly justified. He went on to astound and conquer all hearts in the magic of his splendid oratory. Nor were the more needed graces of humility, zeal and devotion to God wanting in his conduct. As matchless as he was in the pulpit, the more trying ordeal of the fireside but the more endeared him to the purest and best of his brethren in the Lord. He seemed to them some miracle of grace vouchsafed from on high to lead them on in the green pastures and by the still waters of a higher life in the Lord. As they listened to his glowing addresses in church meetings or heard his ready and luminous expositions at home of the deep things in Scripture that had been so dark and inexplicable to them, they would wonder and ponder by what possible means this youth, reared amongst their own unlettered neighbors, should have gained so much insight into the deep things of the theologians.

As has been intimated before in the preceding memoirs of this series, the Baptists and a vast majority of the other white people of the Colony of North Carolina had relapsed into a state of profoundest ignorance so far as literary learning was concerned. Most of their preachers had managed to learn enough to be able to read the Bible, because this was the one *sine qua non* necessary to their license and ordination. But what a pitiful stock of extraneous and yet necessary learning was theirs, to aid them in understanding and explaining to audiences still more ignorant than themselves, the many historical, geographical and oriental allusions so thickly scattered all

through the holy book. What, for example, would be such a commentator's understanding of Luke's enumeration of the nationalities represented at the famous feast of Pentecost. Such men, ignorant from the start as a rule, toiled all the week on their farms, with neither hope nor desire of higher attainments. The beggarly salary allowed them for their pastoral services was so small, that it scarcely entered into their estimate of necessary revenue as a support. They could say with the Indian, "If my preaching is poor, so is my pay." In the general poverty of the country at the time, the people were sorely put to, to get hold of money by any means. English merchants, to aid their own selfish schemes, had procured orders in the councils of royalty in London forbidding the issue of Colonial script, and there was no other circulating medium worth mentioning in the Colony of North Carolina. The steady drain of gold and silver coin sent over the seas to purchase things needed by the wealthier families kept the Province entirely stript of the valuable metals. Besides this, the annual taxes had to be paid in coin after the suppression of Colonial issues of paper bills. We can, then, neither wonder at the smallness of the amounts paid to pastors or the poverty of means generally in the land.

In such a community and amid such clerical peers, Jeremiah Walker flamed up like some resplendent meteor on the bosom of a starless night. His zeal, piety, eloquence and affability to all classes made him a paragon to admiring thousands as he passed on his victorious way from county to county, and later, from State to State. It may be that some reader may incline to the opinion that this picture of the youthful divine is overdrawn. For the benefit of such doubting Thomases, the following fine picture of Mr. Walker is copied from the pages of Rev. Dr. R. B. Semple's History of the Virginia Baptists:

"The invincible energies of his genius towered above every obstruction. He quickly shone forth with such splendor as to make it questionable whether the obscurity of his education, as well as the unlearnedness of his society, did not, by having his mind unshackled from scholastic dogmas and critical strictures, rather advance, than impede, his real greatness. After preaching in his native neighborhood and in Pittsylvania county, Virginia, for some years, he was induced by the new church called Nottoway in Amelia county, Va., to move down and

Sketches of Pioneer Baptist Preachers in North Carolina.

BY JOHN W. MOORE, STATE HISTORIAN.

MEMOIR VII—REV. JEREMIAH WALKER.

CHAPTER TWO.

As the Rev. Jeremiah Walker and other Baptist evangelists of that period traversed Virginia, they found an Episcopal rector and chapel for worship in every parish. The laws and individual inclination had conjoined in bringing over an entirely different class of people to the old Dominion from those who settled the other colonies. No persecuted dissenter was so ignorant as to venture from England or Scotland for exile on James river. It was but "jumping out of the frying pan into the fire." The colony planted at Jamestown in 1607 was the pet of King James I. and all his unlucky dynasty. The settlers who were induced to go there were all of the high church type. They hated Catholics and dissenters with a hatred that seems strangely unaccountable in our generation; but this was counted as God's service in that wicked and adulterous period that preceded the English revolution of 1688. Many families of wealth and consideration transferred themselves and their fortunes to the beautiful land where the doctrines of Laud and Filmer were so much more highly respected than even in merry England. As was natural, the heads of such families became the leaders and lawmakers of the new land. They carried all their prejudices and want of charity into the General Assembly at Williamsburg and enacted such codes of laws as required the restraining powers in London to temper their harshness and cruelty. When King William III. and his gentle partner of the throne had procured from the Convention Parliament the enactment of the famous statute, known and reverenced ever since as the Toleration Act, this law, the noblest monument of one of the greatest kings of modern times, was [illegible]tended for the protection of people aga[illegible]religious persecution in all parts of the British dominions; but it found slow and meager respect in Virginia. Men like Mr. Walker thought themselves comparatively safe from the priestly tyranny of old until they ventured into the battle-field where the Baptists, backed by Pat-

* Edinburgh Medical and Surgical Journal, v. 166.

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rick Henry, Thomas Jefferson and James Madison were struggling for liberty and gospel privileges. That the eloquent young divine had the heart and faith to take his part in such a conflict, adds another to his many claims upon our regard and admiration.

North Carolina Baptist evangelists had been for several years unceasingly active in their incursions into Virginia. As Rev. Dr. Whitsitt remarked in his Wake Forest sermon of 1889, the Old Dominion was chiefly won over to Baptist principles by these missionaries from the Old North State. Thus another element of offense entered into the quarrel which the Churchmen got up with the young preacher from Bute county. He was not only one of the despised Baptists, but an emissary of the same school that had been making such fearful inroads upon Episcopal pastures under the preaching of David Marshall, Samuel Harriss and others. It was a matter of especial offense that these men as a rule were like Mr. Walker from North Carolina. While the British toleration act promised and did secure immunity from the imprisonments and scourgings of older times simply on an allegation of a want of conformity to the State forms of religion, still in the recesses of the enraged Churchmen's hearts there was yet a hope left of vengeance on their religious disturbers. Some soulless and unprincipled lawyer suggested a trick and perversion of the laws by which the most harmless and holy men should be subjected to the pains and penalties intended only for the restraint of the lawless and violent disturbers of the public peace. It was so arranged that Episcopal roughs should be on hand to disturb and break up by open violence any Baptist meeting they could hear of; and then these same men of Belial should go before some compliant magistrate and swear out a peace warrant against the Baptist preachers as disturbers of public tranquility. These villians, who had beaten or half drowned the unoffending man of God, would be used as witnesses to prove that his persistence in preaching the gospel was the whole cause of all the trouble.

It was thus that Mr. Walker, after one of his most powerful discourses, found himself hustled and insulted by the minions of the Establishment, and, amid the tears of his people, was led off as a prisoner to answer for his offense against the peace and dignity of his Majesty's Colony of Virginia. To the warrant alleging his guilt as a disturber of

the public tranquility, he pleaded "not guilty." When the wretched Dogberry of a magistrate had heard the testimony of his accomplices in this mockery of justice, but slight attention was paid to the best citizens of the country as they swore that Mr. Walker's conduct had been entirely peaceful and blameless. Of course, his conviction and punishment were foregone conclusions from the beginning; but when he was called upon to pay a fine and costs, and further to give security for his future good behavior, he told the court plainly that he had committed no offense against the laws of God or man, and should therefore give countenance to no such iniquitous proceedings by paying a single cent; that as for preaching the gospel, he owed allegiance to a higher tribunal than the greatest of earthly courts, and therefore would endure imprisonment, the spoiling of his goods and the loss of life itself sooner than obey any man's orders for his silence on that subject. With such scorn of his jurisdiction, the court was swift to sentence its prisoner to the county jail until a more submissive spirit should mark his course to so exalted a tribunal.

Thus like many of his clerical brethren did this great Baptist preacher suffer the pains and penalties which his ecclesiastical opponents thought were due to heretical obstinacy and presumption in thus daring to give voice to his belief in matters of religion. Mr. Walker's patince and meekness as a prisoner of the Lord, and his glowing sermons preached through the jail windows, made him more than ever an idol of the people. That generous sympathy for the wronged and love of fair play, which marks the Anglo Saxon race in every part of the globe, made him friends in the most unexpected quarters. So far from this persecution staying or stopping the young enthusiast in his work, it but fired his soul into fresh ardor. When the jail doors were opened and he was for shame begged to depart, the people thought him more like one inspired than ever before, as he revelled in the flood tide of resistless argument or melted all hearts with his pathos and tears.

With that noble band of Baptist coadjutors, who through so much labor and tribulation worked out their deliverance from the least dread of future persecution, Mr. Walker hasted on until the glorious end at last came. The fight was long and sore, but with liberty achieved, all the sufferings of the past were counted as dust in the balance. A great people, long misled and mistaken as to human rights, woke up from

their dream of oppression and wrong to become the light and hope of the human race. Had they no other title to renown than the production of Thomas Jefferson, that single fact would be glory enough for unfading immortality. It was through him and his no less illustrious coadjutor, James Madison, that religious liberty was made the law of all the republic. The light kindled first by Roger Williams in Rhode Island having, after so many years, flamed up in the great Virginia beacon, was thus spread over the American nation and is yet on its way round the world. It was to take many years before its final triumph in such places as Massachusetts, but even there the mild and gentle teachings of our Saviour were at length accepted in all their mighty scope of mercy and forbearance, and the difference of men in religious opinion happily ceased to be treated as a crime against worldly and often ungodly magistrates. Even in free and liberal North Carolina, the last vestige of this old, unchristian habit of visiting pains and penalties on people considered unorthodox, was not purged from our constitution until the year of our Lord 1835, and even then such wise, just and capable men as Nathaniel Macon were heard advocating a continuance of a policy which, if enforced, would have unseated William Gaston from the Convention of which he was the greatest pride and ornament.

With the full establishment of American independence and the coming on of the peaceful days after so many years of blood and confusion, the times were still illustrated by the eloquence and activity of the Rev. Jeremiah Walker. The sun of his fame and usefulness was yet undimmed. The olden zeal and fervor in his work of salvation knew no abatement to all human appearances; but like David and many others who have truly served God in this lower world, Mr. Walker was yet to prove the frailty of the flesh even in our best estate. The wisdom and justice of the Saviour's declaration, "Let him that thinketh he standeth take heed to his ways lest he fall," were never more clearly demonstrated than in Mr. Walker's sad and unfortunate ending of his stay in Virginia. Like many another popular preacher, he was the object of almost adoration to many young and lovely women who had professed religion under his ministrations. These, under the cloak of religious attachment, too often burned with less holy sentiments toward the great preacher they so much idolized. In an evil hour for his fame and usefulness, he so far yielded to improper feelings and desires as to seriously

compromise his christian character. His punishment was swift and humiliating. Deposed from the ministry and stript of all the olden respect and preference so long enjoyed, the fallen leader had nothing left but the memory of how much he had forfeited by his sin.

After months of sorrowful repentance, his brethren were induced to give him another trial, and trusting that God had forgiven a soul thus apparently so full of remorse, he was restored to his former privileges as a preacher of the gospel. But nothing could hide the stain on his escutcheon. He found that his usefulness in the old haunts was a thing not to be recovered. On this account he sought strange faces and cover from the knowledge of men by removing to Georgia. There his fall had its legitimate fruit in the lowering of his former high standard as to creed by surrendering all that was good in Calvinistic teachings and the adoption of extreme Arminianism. The old belief that had been so dear in his days of innocence, that told him of his election and adoption through grace, with the further assurance of his his and every other redeemed soul's final perseverance had passed into doubt and dismay. With the great Dutch teacher, he had come to believe that salvation was not only in reach of all the race, but was dependent solely upon their own wills and works. His great debate with Rev. Silas Mercer before the General Association of Virginia, showed that all the astuteness and oratory of the past were yet his; but the soul and cream of his Baptist strength had been lost in the sense of his double departure from purity and the truth. The case of Mr. Walker, along with others of a similar nature, might well show the people of all creeds calling on the name of Christ, how useless it is to continue men, convicted of disgraceful sins, in their former pastoral relations. Such offences against God and man are sure to have their legitimate effects on the soul of the offender. Peter sinned grievously and was restored to God's favor; but we must remember that was an age of miracles. The forgiveness and absolution of our Lord could call even the dead back to life, but we have no such resurrections now. The minister who, in his sacred functions deliberately tramples on God's mercy and the trust of his people, is forever unworthy of return to his forfeited place as the under shepherd of the Lord. If he is truly repentant, let the church restore him as a layman, but as a pastor and guide, never.

cipitated by carbonate of soda, and the precipitated lime and magnesia may be separated from each other by the rules given page 249.

XXI.—*Muriate of Ammonia,—Ammoniæ Murias, P. L.—Sal Ammoniac.*

This salt ought to be entirely volatilized, by a low heat, when laid on a heated iron. It sometimes contains sulphate of ammonia, however, which, being also volatile, cannot be thus detected. To ascertain the presence of the latter salt, add the muriate or nitrate of barytes, which will indicate the sulphate by a copious and insoluble precipitate.

XXII.—*Acetate of Potash,—Potassæ Acetas, P. L.*

Genuine acetate of potash is perfectly soluble in four times its weight of alcohol, and may thus be separated from other salts that are insoluble in alcohol. The tartrate of potash (soluble tartar) is the adulteration most likely to be employed. This may be discovered by adding a solution of tartaric acid, which, if the suspected salt be present, will occasion a copious precipitate. The tartrate is also detected by its forming a precipitate with acetate of lead or muriate of barytes, soluble in acetic or muriatic acid; and sulphates by a precipitate with the same agents, insoluble in acids.

XXIII.—*Neutral Tartrate of Potash,—Potassæ Tartras, P. L.—Soluble Tartar.*

This salt should afford a very copious precipitate on adding tartarous acid. The only salt likely to be mixed with it is sulphate of soda, which may be detected by a precipitate with muriated barytes, insoluble in diluted muriatic acid.

XXIV.—*Acidulous Tartrate of Potash.—Potassæ Supertartras, P. L.—Cream of Tartar.*

The only substance with which this salt is likely to be adulterated is sulphate of potash. To determine whether this be present, pour, on about half an ounce of the powdered crystals, two or three ounce-measures of distilled water; shake the mixture frequently, and let it stand one or two hours. The sulphate of potash, being more soluble than the tartrate, will be taken up; and may be known by the bitter taste of the solution, and by a precipitate, on adding muriate of barytes, which will be insoluble in muriatic acid.

XXV.—*Compound Tartrate of Soda and Potash,—Soda Tartarizata, P. L.—Rochelle or Seignette's Salt.*

Sulphate of soda, the only salt with which this may be expected to be adulterated, is discovered by adding to a solution of Rochelle salt the acetate of lead or muriate of barytes.—The former, if the sulphate be present, affords a precipitate insoluble in acetous acid, and the latter one insoluble in muriatic acid.

XXVI.—*Sulphate of Magnesia,—Magnesiæ Sulphas, P. L.—Epsom Salt.*

This salt is very likely to be adulterated with sulphate of soda, or Glauber's salt, which may be made to resemble the magnesian salt in appearance, by stirring it briskly at the moment when it is about to crystallize. The fraud may be discovered very readily if the salt consist entirely of the sulphate of soda, because no precipitation will ensue on adding carbonate of potash. If only a part of the salt be sulphate of soda, detection is not so easy, but may still be accomplished. For, since 100 parts of pure sulphate of magnesia give between 30 and 40 of the dry carbonate, when completely decomposed by carbonate of potash, if the salt under examination afford a considerably less proportion, its sophistication may be fairly inferred: or, to discover the sulphate of soda, precipitate all the magnesia by pure ammonia, with the aid of heat. Decant the clear liquor from the precipitate, filter it, and, after evaporation to dryness, apply such a heat as will volatilize the sulphate of ammonia, when that of soda will remain fixed.

Muriate of magnesia or of lime may be detected by the salt becoming moist when exposed to the air, and by a precipitation with nitrated silver, after nitrate of barytes has separated all the sulphuric acid and magnesia. Lime is discoverable by oxalic acid.

XXVII.—*Sulphate of Alumine,—Alum.*

Perfectly pure alum should contain neither iron nor copper. The former is manifested by adding, to a solution of alum, prussiate of potash, and the latter by an excess of pure ammonia.

XXVIII.—*Borate of Soda,—Sodæ Boras, P. L.—Borax.*

Borate of soda, if adulterated at all, will probably be so with alum or fused muriate of soda. To discover these, borax must be dissolved in water, and its excess of alkali be saturated with nitric acid. Nitrate of barytes, added to this saturated solution, will detect the sulphuric salt, and nitrate of silver the muriate of soda.

XLIX.—*Spirit of Wine, Alcohol, and Æthers.*

The only decisive mode of ascertaining the purity of spirit of wine and of æthers, is by determining their specific gravity. Highly rectified alcohol should have the specific gravity of 800 to 1000. Common spirit of wine 837. Sulphuric æther 739. The *spiritus ætheris sulphurici, P. L.* or sweet spirit of vitriol, about 753,—and nitric æther, the *spiritus ætheris nitrosus*, or sweet spirit of nitre, 908. The æthers ought not to redden the colour of litmus, nor ought those formed from sulphuric acid to give any precipitation with solution of barytes.

L.—*Essential or Volatile Oils.*

As essential oils constitute only a very small proportion of the vegetables from which they are obtained, and bear generally a very high price, there is a considerable temptation to adulterate them. They are found sophisticated, either with cheaper volatile oils, with fixed oils, or with the spirit of wine. The fixed oils are discovered by distillation with a very gentle heat, which elevates the essential oils, and leaves the fixed ones. These last may, also, be detected by moistening a little writing-paper with the suspected oil, and holding it before the fire. If the oil be entirely essential, no stain will remain on the paper. Alcohol, also, detects the fixed oils, because it only dissolves the essential ones, and the mixture becomes milky. The presence of cheaper essential oils is discovered by the smell. Alcohol, a cheaper liquid than some of the most costly oils, is discovered by adding water, which, if alcohol be present, occasions a milkiness.

CHAPTER III.

USE OF CHEMICAL RE-AGENTS TO CERTAIN ARTISTS AND MANUFACTURERS.

TO point out all the beneficial applications of chemical substances to the purposes of the arts, would require a distinct and very extensive treatise. In this place I have no farther view than to describe the mode of detecting adulterations in certain articles of commerce; the strength and purity of which are essential to the success of chemical processes.

I.—*Mode of detecting the Adulteration of Potashes, Pearlashes, and Barilla.*

Few objects of commerce are sophisticated to a greater extent than the alkalis, to the great loss and injury of the bleacher, the dyer, the glass-maker, the soap-boiler, and of all other artists who are in the habit of employing these substances. In the first part of this work (see vol. i. page 223) I have already given rules for discovering such adulterations: and to what has been said, I apprehend it is only necessary to add the directions of Mr. Kirwan, intended to effect the same end, but differing in the mode. They are transcribed from his paper, entitled, "Experiments on the Alkaline Substances used in Bleaching;"—see Transactions of the Irish academy for 1789.*

"To discover whether any quantity of fixed alkali worthy of attention exists in any saline compound, dissolve one ounce of it in boiling water, and into this solution let fall a drop of a solution of sublimate corrosive; this will be converted into a brick-colour, if an alkali be present, or into a brick-colour mixed with yellow, if the substance tried contains lime.

"But the substances used by bleachers being always impregnated with an alkali, the above trial is in general superfluous, except for the purpose of detecting lime. The quantity of alkali is therefore what they should chiefly be solicitous to determine, and for this purpose,

"1st, Procure a quantity of alum, suppose one pound, reduce it to powder, wash it with cold water, and then put it into a teapot, pouring on it three or four times its weight of boiling water.

"2dly, Weigh an ounce of the ash or alkaline substance to be tried, powder it, and put it into a Florence flask with one pound of pure water (common water, boiled for a quarter of an hour, and afterwards filtered through paper, will answer;) if the substance to be examined be of the nature of barilla or potash, or half a pound of water if it contain but little earthy matter, as pearlash. Let them boil for a quarter of an hour; when cool, let the solution be filtered into another Florence flask.

"3dly, This being done, gradually pour the solution of alum hot into the alkaline solution also heated; a precipitation will immediately appear; shake them well together, and let the efferves-

* Directions for the assay of potash, by the intervention of nitrate of strontites, may be found in the 41st volume of the *Annales de Chimie*, page 113.

cence, if any, cease before more of the aluminous solution be added; continue the addition of the alum until the mixed liquor, when clear, turns syrup of violets or paper tinged blue by radishes, or by litmus, red; then pour the liquor and precipitate on a paper-filter, placed in a glass funnel. The precipitated earth will remain on the filter; pour on this a pound or more of hot water, gradually, until it passes tasteless; take up the filter, and let the earth dry on it until they separate easily. Then put the earth into a cup of Staffordshire ware, place it on hot sand, and dry the earth until it ceases to stick to glass or iron; then pound it, and reduce it to powder in the cup with a glass pestle, and keep it a quarter of an hour in a heat of from 470° to 500°.

"4thly, The earth being thus dried, throw it into a Florence flask, and weigh it; then put about one ounce of spirit of salt into another flask, and place this in the same scale as the earth, and counterbalance both in the opposite scale; this being done, pour the spirit of salt gradually into the flask that contains the earth; and, when all effervescence is over (if there be any,) blow into the flask, and observe what weight must be added to the scale containing the flasks to restore the equilibrium; subtract this weight from that of the earth, the remainder is a weight exactly *proportioned* to the weight of mere alkali of that particular species which is contained in one ounce of the substance examined; all beside is superfluous matter.

"I have said, that alkalis of the *same species* may thus be directly compared, because alkalis of *different* species cannot but require the intervention of another proportion; and the reason is, because *equal* quantities of alkalis of different species precipitate unequal quantities of earth of alum: Thus 100 parts, by weight, of mere vegetable alkali precipitate 78 of earth of alum, but 100 parts of *mineral* alkali precipitate 170.8 parts of that earth. Therefore the precipitation of 78 parts of earth of alum, by vegetable alkali, denotes as much of this, as the precipitation of 170.8 of that earth by the mineral alkali, denotes of the mineral alkali. Hence the quantities of alkali in all the different species of potashes, pearl-ashes, weed or wood ashes, may be immediately compared with the above test, as they all contain the vegetable alkali; and the different kinds of kelp or kelps manufactured in different places, and the different sorts of barilla, may thus be compared, because they all contain the mineral alkali. But kelps and potashes, as they contain different sorts of alkali, can only be compared together by means of the proportion above indicated."

II.—*Mode of detecting the Adulteration of Manganese.*

In the section on drugs, instructions may be found for discovering impurities in several chemical preparations, employed by the artist, as cerusse or white lead, red lead, verdegris, &c. No rules, however, have been given for examining manganese, which is a substance that varies much in quality, and is often sophisticated; as the bleachers experience, to their no small disappointment and loss.

The principle defect of the manganese arises from the admixture of chalk, which is not always an intentional adulteration, but is sometimes found united with it, as it occurs in the earth. When to this impure manganese mixed with muriate of soda, the sulphuric acid is added, the materials effervesce and swell considerably, and a large proportion passes into the receiver; in consequence of which the bleaching liquor is totally spoiled. This accident has, to my knowledge, frequently happened, and can only be prevented by so slow and cautious an addition of the acid, as is nearly inconsistent with the business of an extensive bleaching work. The presence of carbonate of lime may be discovered in manganese, by pouring, on a portion of this substance, nitric acid diluted with 8 or 10 parts of water. If the manganese be good, no effervescence will ensue, nor will the acid dissolve any thing; but, if carbonate of lime be present, it will be taken up by the acid. To the solution add a sufficient quantity of carbonate of potash to precipitate the lime, wash the sediment with water, and dry it. Its weight will show how much chalk the manganese under examination contained.

Another adulteration of manganese, that may, perhaps, be sometimes practised, is the addition of some ores of iron. This impurity is less easily discovered. But if the iron be in such a state of oxidation as to be soluble in muriatic acid, the following process may discover it. Dissolve a portion, with the assistance of heat, in concentrated muriatic acid, dilute the solution largely with distilled water, and add a solution of crystallized carbonate of potash. The manganese will remain suspended, by the excess of carbonic acid, on mixing the two solutions, but the iron will be precipitated in the state of a coloured oxide.

From an observation of Klaproth (Essays, vol. i. page 572,) it appears that oxides of iron and manganese are separable by nitrous acid with the addition of sugar, which takes up the manganese only.

The chemical substances, or re-agents, required for separating the constituent parts of the soil, are muriatic acid (spirit of salt,) sulphuric acid, pure volatile alkali dissolved in water, solution of prussiate of potash, soap lye, solution of carbonate of ammonia, of muriate of ammonia, solution of neutral carbonate of potash, and nitrate of ammonia. An account of the nature of these bodies, and their effects, may be found in the chemical works already noticed; and the re-agents are sold, together with the instruments mentioned above, by Mr. Knight, Foster-lane, Cheapside, arranged in an appropriate chest.

IV.—*Mode of collecting Soils for Analysis.*

In cases when the general nature of the soil of a field is to be ascertained, specimens of it should be taken from different places, two or three inches below the surface, and examined as to the similarity of their properties. It sometimes happens, that upon plains the whole of the upper stratum of the land is of the same kind, and in this case, one analysis will be sufficient; but in valleys, and near the beds of rivers, there are very great differences, and it now and then occurs that one part of a field is calcareous, and another part siliceous; and in this case, and in analogous cases, the portions different from each other should be separately submitted to experiment.

Soils when collected, if they cannot be immediately examined, should be preserved in phials quite filled with them, and closed with ground glass stoppers.

The quantity of soil, most convenient for a perfect analysis, is from two to four hundred grains. It should be collected in dry weather, and exposed to the atmosphere till it becomes dry to the touch.

The specific gravity of a soil, or the relation of its weight to that of water, may be ascertained by introducing into a phial, which will contain a known quantity of water, equal volumes of water and of soil; and this may be easily done by pouring in water till it is half full, and then adding the soil till the fluid rises to the mouth; the difference between the weight of the soil and that of the water will give the result. Thus if the bottle contains four hundred grains of water, and gains two hundred grains when half filled with water and half with soil, the specific gravity of the soil will be 2, that is, it will be twice as heavy as water, and if it gained one hundred and sixty-five grains, its specific gravity would be 1825, water being 1000.

It is of importance, that the specific gravity of a soil should be known, as it affords an indication of the quantity of animal and vegetable matter it contains; these substances being always most abundant in the lighter soils.

The other physical properties of soils should likewise be examined before the analysis is made, as they denote, to a certain extent, their composition, and serve as guides in directing the experiments. Thus siliceous soils are generally rough to the touch, and scratch glass when rubbed upon it; aluminous soils adhere strongly to the tongue, and emit a strong earthy smell when breathed on; and calcareous soils are soft, and much less adhesive than aluminous soils.

V.—*Mode of ascertaining the Quantity of Water of Absorption in Soils.*

Soils, though as dry as they can be made by continued exposure to air, in all cases still contain a considerable quantity of water, which adheres with great obstinacy to the earths and animal and vegetable matter, and can only be driven off from them by a considerable degree of heat. The first process of analysis is, to free the given weight of soil from as much of this water as possible, without in other respects affecting its composition; and this may be done by heating it for ten or twelve minutes over an Argand's lamp, in a bason of porcelain, to a temperature equal to 300°* Fahrenheit; and in case a thermometer is not used, the proper degree may be easily ascertained, by keeping a piece of wood in contact with the bottom of the dish; as long as the colour of the wood remains unaltered, the heat is not too high; but when the wood begins to be charred, the process must be stopped. A small quantity of water will perhaps remain in the soil even after this operation, but it always affords useful comparative results; and if a higher temperature were employed, the vegetable or animal matter would undergo decomposition, and in consequence the experiment be wholly unsatisfactory.

The loss of weight in the process should be carefully noted; and when in 400 grains of soil it reaches as high as 50, the soil may be considered as in the greatest degree absorbent, and retentive of water, and will generally be found to contain a large proportion of aluminous earth. When the loss is only from 20 to 10,

* In several experiments, in which this process has been carried on by distillation, I have found the water that came over pure, and no sensible quantity of other volatile matter was produced.

the land may be considered as only slightly absorbent and retentive, and the siliceous earth as most abundant.

VI.—*Of the Separation of Stones, Gravel, and Vegetable Fibres, from Soils.*

None of the loose stones, gravel, or large vegetable fibres should be divided from the pure soil till after the water is drawn off; for these bodies are themselves often highly absorbent and retentive, and in consequence influence the fertility of the land. The next process, however, after that of heating, should be their separation, which may be easily accomplished by the sieve, after the soil has been gently bruised in a mortar. The weights of the vegetable fibres or wood, and of the gravel and stones, should be separately noted down, and the nature of the last ascertained; if calcareous, they will effervesce with acids; if siliceous, they will be sufficiently hard to scratch glass; and if of the common aluminous class of stones, they will be soft, easily scratched with a knife, and incapable of effervescing with acids.

XII.—*Separation of the Sand and Clay, or Loam, from each other.*

The great number of soils, besides gravel and stones, contain larger or smaller proportions of sand of different degrees of fineness; and it is a necessary operation, the next in the process of analysis, to detach them from the parts in a state of more minute division, such as clay, loam, marl, and vegetable and animal matter. This may be effected in a way sufficiently accurate, by agitation of the soil in water. In this case, the course sand will generally separate in a minute, and the finer in two or three minutes, whilst the minutely divided earthy, animal, or vegetable matter, will remain in a state of mechanical suspension for a much longer time; so that, by pouring the water from the bottom of the vessel, after one, two, or three minutes, the sand will be principally separated from the other substances, which, with the water containing them, must be poured into a filter, and after the water has passed through, collected, dried, and weighed. The sand must likewise be weighed, and their respective quantities noted down. The water of lixiviation must be preserved, as it will be found to contain the saline matter, and the soluble animal or vegetable matters, if any exist in the soil.

VIII.—*Examination of the Sand.*

By the process of washing and filtration, the soil is separated into two portions, the most important of which is generally the finely divided matter. A minute analysis of the sand is seldom or never necessary, and its nature may be detected in the same manner as that of the stones or gravel. It is always either siliceous sand, or calcareous sand, or a mixture of both. If it consist wholly of carbonate of lime, it will be rapidly soluble in muriatic acid, with effervescence; but if it consist partly of this substance, and partly of siliceous matter, the respective qualities may be ascertained by weighing the residuum after the action of the acid, which must be applied till the mixture has acquired a sour taste, and has ceased to effervesce. This residuum is the siliceous part: it must be washed, dried, and heated strongly in a crucible; the difference between the weight of it and the weight of the whole, indicates the proportion of calcareous sand.

IX.—*Examination of the finely divided Matter of Soils, and Mode of detecting mild Lime and Magnesia.*

The finely divided matter of the soil is usually very compound in its nature; it sometimes contains all the four primitive earths of soils, as well as animal and vegetable matter; and to ascertain the proportions of these with tolerable accuracy, is the most difficult part of the subject.

The first process to be performed, in this part of the analysis, is the exposure of the fine matter of the soil to the action of the muriatic acid. This substance should be poured upon the earthy matter in an evaporating bason, in a quantity equal to twice the weight of the earthy matter, but diluted with double its volume of water. The mixture should be often stirred, and suffered to remain for an hour, or an hour and a half, before it is examined.

If any carbonate of lime, or of magnesia, exist in the soil, they will have been dissolved in this time by the acid, which sometimes takes up likewise a little oxide of iron, but very seldom any alumine.

The fluid should be passed through a filter; the solid matter collected, washed with rain water, dried at a moderate heat, and weighed. Its loss will denote the quantity of solid matter taken up. The washings must be added to the solution, which, if not sour to the taste, must be made so by the addition of fresh acid, when a little solution of common prussiate of potash must be mixed with the whole. If a blue precipitate occurs, it denotes the

presence of oxide of iron, and the solution of the prussiate must be dropped in till no farther effect is produced. To ascertain its quantity, it must be collected in the same manner as other solid precipitates, and heated red; the result is oxide of iron.

Into the fluid, freed from oxide of iron, a solution of neutralized carbonate of potash must be poured till all effervescence ceases in it, and till its taste and smell indicate a considerable excess of alkaline salt.

The precipitate that falls down is carbonate of lime; it must be collected on the filter, and dried at a heat below that of redness.

The remaining fluid must be boiled for a quarter of an hour, when the magnesia, if any exist, will be precipitated from it, combined with carbonic acid, and its quantity is to be ascertained in the same manner as that of the carbonate of lime.

If any minute proportion of alumine should, from peculiar circumstances, be dissolved by the acid, it will be found in the precipitate with the carbonate of lime, and it may be separated from it by boiling for a few minutes with soap lye, sufficient to cover the solid matter.—This substance dissolves alumine, without acting upon carbonate of lime.

Should the finely divided soil be sufficiently calcareous to effervesce very strongly with acids, a very simple method may be adopted for ascertaining the quantity of carbonate of lime, and one sufficiently accurate in all common cases.

Carbonate of lime, in all its states, contains a determinate proportion of carbonic acid. *i. e.* about 45 *per cent.*; so that when the quantity of this elastic fluid, given out by any soil during the solution of its calcareous matter in an acid, is known, either in weight or measure, the quantity of carbonate of lime may be easily discovered.

When the process by diminution of weight is employed, two parts of the acid, and one part of the matter of the soil must be weighed in two separate bottles, and very slowly mixed together till the effervescence ceases; the difference between their weight before and after the experiment, denotes the quantity of carbonic acid lost; for every four grains and a half of which, ten grains of carbonate of lime must be estimated.

The best method of collecting the carbonic acid, so as to discover its volume, is by the pneumatic apparatus, the construction and application of which is described at the end of this paper.

The estimation is, for every ounce measure of carbonic acid, two grains of carbonate of lime.

X.—*Mode of ascertaining the Quantity of insoluble finely divided Animal and Vegetable Matter.*

After the fine matter of the soil has been acted upon by muriatic acid, the next process is to ascertain the quantity of finely divided insoluble animal and vegetable matter that it contains.

This may be done with sufficient precision, by heating it to strong ignition in a crucible over a common fire till no blackness remains in the mass. It should be often stirred with a metallic wire, so as to expose new surfaces continually to the air; the loss of weight that it undergoes denotes the quantity of the substance that it contains destructible by fire and air.

It is not possible to ascertain whether this substance is wholly animal or vegetable matter, or a mixture of both. When the smell emitted during the incineration is similar to that of burnt feathers, it is a certain indication of some animal matter; and a copious blue flame at the time, of ignition, almost always denotes a considerable proportion of vegetable matter. In cases when the experiment is needed to be very quickly performed, the destruction of the decomposible substances may be assisted by the agency of nitrate of ammonia, which, at the time of ignition, may be thrown gradually upon the heated mass, in the quantity of twenty grains for every hundred of residual soil. It affords the principle necessary to the combustion of the animal and vegetable matter, which it causes to be converted into elastic fluids; and is itself at the same time decomposed and lost.

XI.—*Mode of separating Aluminous and Siliceous Matter, and Oxide of Iron.*

The substances remaining after the decomposition of the vegetable and animal matter, are generally minute particles of earthy matter, containing usually alumine and silex with combined oxide of iron.

To separate these from each other, the solid matter should be boiled for two or three hours with sulphuric acid, diluted with four times its weight of water; the quantity of the acid should be regulated by the quantity of solid residuum to be acted on, allowing for every hundred grains two drachms, or one hundred and twenty grains of acid.

The substance, remaining after the action of the acid, may be

XX.—*Advantages of Improvements made by changing the Composition of Earthy Parts of Soils.*

From the great difference of the causes that influence the productiveness of lands, it is obvious, that, in the present state of science, no certain system can be devised for their improvement, independent of experiment; but there are few cases in which the labour of analytical trials will not be amply repaid by the certainty with which they denote the best methods of amelioration; and this will particularly happen, when the defect of composition is found in the proportions of the primitive earths.

In supplying animal or vegetable manure, a temporary food only is provided for plants, which is in all cases exhausted by means of a certain number of crops; but when a soil is rendered of the best possible constitution and texture, with regard to its earthy parts, its fertility may be considered as permanently established. It becomes capable of attracting a very large portion of vegetable nourishment from the atmosphere, and of producing its crops with comparatively little labour and expense.

Description of the Apparatus for the Analysis of Soils.

Pl. iv. fig. 44; *a*, *b*, *c*, *d*, *e*, *f*. The different parts of the apparatus required for measuring the quantity of elastic fluid given out during the action of an acid on calcareous soils. *a* Represents the bottle for containing the soil; *b*, the bottle containing the acid, furnished with a stop-cock; *c*, the tube connected with the flaccid bladder; *d*, *f*, the graduated measure; *e*, the bottle for containing the bladder. When this instrument is used, a given quantity of soil is introduced into *a*; *b*, is filled with muriatic acid, diluted with an equal quantity of water; and the stop-cock being closed, is connected with the upper orifice of *a*, which is ground to receive it. The tube *c* is introduced into the lower orifice of *a*, and the bladder connected with it placed in its flaccid state in *e*, which is filled with water. The graduated measure is placed under the tube of *e*. When the stop-cock of *b* is turned, the acid flows into *a*, and acts upon the soil; the elastic fluid generated passes through *c* into the bladder, and displaces a quantity of water in *e* equal to it in bulk, and this water flows through the tube into the graduated measure; the water in which gives, by its volume, the indication of the proportion of carbonic acid disengaged from the soil; for every ounce measure of which two grains of carbonate of lime may be estimated.

CHAPTER V.

MISCELLANEOUS USES OF CHEMICAL RE-AGENTS.

I.—*Removal of Ink Stains.*

THE stains of ink on cloth, paper, or wood, may be removed by almost all acids; but those acids are to be preferred which are least likely to injure the texture of the stained substance. The muriatic acid, diluted with five or six times its weight of water, may be applied to the spot, and, after a minute or two, may be washed off, repeating its application as often as may be found necessary. But the vegetable acids are attended with less risk, and are equally effectual. A solution of the oxalic, citric, or tartaric acids, in water, may be applied to the most delicate fabrics, without any danger of injuring them; and the same solutions discharge from paper, written, but not printed, ink. Hence they may be employed in cleaning books, which have been defaced by writing on the margin, without impairing the text.

II.—*Iron Stains.*

These may be occasioned either by ink stains, which, on the application of soap, are changed into iron stains, or by the direct contact of rusted iron.—They may be removed by diluted muriatic acid, or by one of the vegetable acids already mentioned. When suffered to remain long on cloth, they become extremely difficult to take out, because the iron, by repeated moistening with water and exposure to the air, acquires such an addition of oxygen as renders it insoluble in acids. Even these spots, however, may be discharged, by applying first a solution of recently prepared muriate of tin, which must be well washed from the cloth, and afterwards a liquid acid. The muriate of tin, in this case, extracts part of the oxygen from the iron, and renders it soluble in dilute acids.

III.—*Fruit and Wine Stains.*

These are best removed by a watery solution of the oxygenized muriatic acid (see chap. xiv. sect. 3,) or by that of oxygenized muriate of potash or lime, to which a little sulphuric acid has been added. The stained spot may be steeped in one of these solutions till it is discharged; but the solution can only be applied with safety to white goods, because the uncombined oxygenized acid discharges all printed and dyed colours. A convenient mode of

applying the oxygenized acid, easily practicable by persons who have not the apparatus for saturating water with the gas, is as follows: Put about a table-spoonful of muriatic acid (spirit of salt) into a tea-cup, and add to it about a tea-spoonful of powdered manganese. Then set this cup in a larger one filled with hot water. Moisten the stained spot with water, and expose it to the fumes that arise from the tea-cup. If the exposure be continued a sufficient length of time, the stain will disappear.

Stains on silk may be removed by a watery solution of sulphurous acid, or by the fumes of burning sulphur.

IV.—*Spots of Grease*

May be removed by a diluted solution of pure potash; but this must be cautiously applied, to prevent injury to the cloth. Stains of *white wax*, which sometimes fall upon the clothes from wax candles, are removeable by spirit of turpentine or sulphuric ether. —The marks of *white paint* may also be discharged by the last-mentioned agents.

APPENDIX I.

OF THE RECENT DISCOVERIES IN CHEMISTRY.

Since this work was committed to the press, several new facts have been discovered, the importance of which requires that they should be noticed, though published too late to be inserted in their proper place. Of these the principal part are contained in Mr. Davy's last communication to the Royal Society, a copy of of which he has been so obliging as to transmit to me, previously to its publication in the Philosophical Transactions.* These discoveries lead to some changes in the views, which have been given in the first volume, of the nature of certain chemical agents. In researches, indeed, so refined and complicated, and involving so many sources of error, it is to be expected that frequent changes will be required, both in the enunciation of facts, and in the conclusions deduced from them.

I.—*On Ammonia—Its Formation from Charcoal and Pearlash—Presence of Oxygen in it—Amalgam of Mercury and Ammonium.*

From the researches of Mr. Davy, of which an outline has been given at page 194 vol. i. it appeared to follow that, by the action of potassium on ammonia, the nitrogen which enters into the constitution of that alkali, suffers a decomposition, since a less quantity of nitrogen gas is obtained by the agency of this metal than by electrical analysis. At the same time the increased production of hydrogen gas pointed out hydrogen as a probable element of nitrogen. MM. Gay Lussac and Thenard, however, have asserted that the fusible substance, generated by heating potassium in ammonia, may be made to give out the whole of the ammonia which has been absorbed by the process, two fifths as ammonia, one fifth as hydrogen and nitrogen; and the remaining two fifths, by the addition of water, in the form of volatile alkali. They agree with Mr. Davy as to the evolution of hydrogen; but maintain that as all the ammonia is recovered, the hydrogen gas must be furnished by the decomposition of potassium.

These discordant results have led Mr. Davy to repeat his former experiments, with the observance of every possible precau-

* Part I. for 1810.

however, it is partially decomposed by the air in the water, so that it is not easy to say whether the power is inherent in it, or depends on the diffusion of a small quantity of muriatic acid through it. In other respects, it resembles a weak acid, combining with water and the alkalis. It precipitates most metallic solutions. It is instantly decomposed by oxy-muriatic acid, depositing a film at first metallic, but which is soon converted into muriate of tellurium.

The phenomena produced by substituting ARSENIC for tellurium in similar experiments were considerably different. Arsenic, made the negative surface in water, became dark coloured and threw down a brown powder, but it likewise gave off a considerable quantity of hydrogen gas. Negatively electrified in contact with solid potash, an alloy of potassium and arsenic was formed of a dark grey colour and perfectly metallic, which gave off arseniuretted hydrogen by the action of water. Potassium and arsenic, simply heated together, combined with such violence as to exhibit an actual inflammation, and yielded a similar alloy.

By heating these alloys of tellurium and arsenic with potassium in ammoniacal gas, an elastic fluid was generated, which consisted of four sixths nitrogen, instead of being pure hydrogen, as in the action of potassium alone. If it be said, then, that the metal and not the ammonia is decomposed in processes of this kind, it must be considered (Mr. Davy argues) in some cases as a compound of nitrogen, and in others as a compound of hydrogen, which are contradictory assumptions.

V.—*Nature of Sulphur, Phosphorus, and their Combinations with Hydrogen.*

From the experiments of Mr. Davy, of which an abstract is given in the first volume, it appeared extremely probable that both sulphur and phosphorus contain hydrogen. The intense ignition, which these bodies exhibit during their combination with potassium, led him also to suspect that they might contain oxygen; but this inference has since been rendered questionable by the fact, that similar phenomena attend the action of potassium on tellurium and arsenic. Neither is the diminution of the power of potassium to decompose water, after its union with sulphur and phosphorus, so clearly established, as to furnish proof of the presence of oxygen in these bodies. The idea, however, is still supported by several analogies, and especially by their property of being non-conductors of electricity.

Sulphuretted hydrogen gas, Mr. Davy states to weigh 35 grains for 100 cubical inches; and as the gas contains a volume of hydrogen gas precisely equal to its own, it will consist of 2.27 hydrogen, and 32.73 sulphur; and hence 100 parts by weight will contain

93.51 sulphur
6.49 hydrogen

100

When sulphuretted hydrogen is decomposed by common electricity, there is a slight diminution of volume, and the precipitated sulphur appears to contain a little hydrogen; but when Voltaic sparks are transmitted through it, the sulphur is precipitated in its common form, and there is no change of volume.

Arsenuretted and phosphuretted hydrogen gases are also decomposed by electricity without changing their bulk. But neither arsenic nor phosphorus are separated in their ordinary states. The phosphorus has a dark colour, and the arsenic is a brown powder; and both substances probably contain hydrogen. If potassium be brought into contact with these gases in smaller quantity than is necessary to decompose the whole, there is always an expansion of volume. Both gases, therefore, must contain more than their own volume of hydrogen, probably half as much more or twice as much more. From experiments on the weight of these gases, Mr. Davy finds that 100 cubic inches of arsenuretted hydrogen weigh about 15 grains, and 100 cubic inches of phosphuretted hydrogen about 10 grains. Mr. Dalton, however, from recent experiments, is disposed to consider phosphuretted hydrogen as much heavier; and to rate the 100 cubical inches at 26 grains.

VI.—*Of Mr. Dalton's New System of Chemical Elements.*

I have already (vol. i. page 60) stated very briefly the principle on which Mr. Dalton has founded his new system of chemical elements, or what may be called the *atomic system*. Into the details of this theory, or the analogies on which it rests, I have purposely, however, foreborn to enter; because nothing more than a brief outline has hitherto been laid before the public by the author himself. In the second part of his "New System of Chemical Philosophy," which is nearly ready for publication, not only the facts, many of which have been obtained by his own elaborate researches, but the train of reasoning to which they have led, will be fully developed. In the mean time I subjoin, from the first part of

Mr. Dalton's work, the table of the relative weights of several bodies, with some corrections, resulting from his late experience, which he has been so obliging as to communicate to me. To explain the method in which these numbers have been deduced, it may be proper to add the following remarks.

Let us suppose that any two elementary bodies *a* and *b* form a binary compound, and that they have been proved experimentally to unite in the proportion by weight of 5 of the former to 4 of the latter; then, since according to the hypothesis, they unite particle to particle, these numbers will express the relative weights of their atoms. But besides combining atom to atom singly, one atom of *a* may also combine with 2 of *b* or with 3, 4, &c. Or, reversely, 1 of *b* may unite with 2 of *a* or with 3, 4, &c. When such a series of compounds exists, the relative proportion of their elements ought necessarily, on analysis, to be proved to be 5 of *a* to 4 of *b*; or 5 to (4 + 4=)8; or 5 to (4 + 4 + 4 =) 12; &c.; or, contrariwise, 4 of *b* to 5 of *a*, or 4 to (5 + 5 =) 10; or 4 to (5 + 5 + 5 =) 15. Between these, there ought to be no intermediate compounds; and the existence of any such would be fatal to the hypothesis.

To verify these numbers, it may be proper to examine the combinations of *a* and *b* with some third substance, for example with *c*. Let us suppose that in the binary compound of *a* and *c*, analysis discovers 5 parts of the former and 3 of the latter. Then, if *c* and *b* are also capable of forming a binary compound, their relative proportions by weight in this compound ought to be 4 of *b* to 3 of *c*, since these numbers denote the relative weight of their atoms. Now this is precisely the method, by which Mr. Dalton has deduced and verified the relative weights of oxygen, hydrogen, and nitrogen; the two first from the known composition of water; and the two last from the proportion of the elements of ammonia. Extending the comparison to a number of other bodies, he has obtained a scale of the relative weights of their atoms.

The hypothesis, therefore, although its leading principle be a gratuitous assumption, must stand or fall by the results of analysis. The instances in which it agrees with these results, are already very numerous; and none have hitherto been shown to be directly contradictory to it. If it should continue to derive support from the progress of discovery, its importance will be scarcely less felt in assisting and directing future investigations, than in determining the accuracy of our present knowledge.

Relative weights of the ultimate atoms of several bodies.

Hydrogen	1	Potassium	43
Nitrogen	5	Strontites	46
Carbon	5	Barytes	68
Oxygen	7	Iron	50
Phosphorus	9	Zinc	56
Sulphur	13	Copper	56
Magnesia	17	Lead	95
Lime	24	Silver	100
Soda	28	Platina	100
Sodium	29	Gold	140
Potash	42	Mercury	167

BINARY COMPOUNDS.

An atom of WATER or STEAM, composed of one oxygen and one hydrogen, retained in physical contact by a strong affinity; and supposed to be surrounded by a common atmosphere of heat - - - - - - - - - - 8

An atom of AMMONIA, composed of one atom of nitrogen and one atom of hydrogen - - - - - - - - 6

An atom of NITROUS GAS composed of one atom of nitrogen and one of oxygen - - - - - - - - 12

An atom of OLEFIANT GAS composed of one atom of carbon and one of hydrogen - - - - - - - - 6

An atom of CARBONIC OXIDE composed of one atom of carbon and one of oxygen - - - - - - - - 12

An atom of SULPHURETTED HYDROGEN composed of one atom of sulphur and one of hydrogen - - - - - 14

TERNARY COMPOUNDS.

An atom of NITROUS OXIDE two nitrogen and one oxygen - - - - - - - - - - - - - 17

An atom of NITRIC ACID one nitrogen and two oxygen - - - - - - - - - - - - - 19

An atom of CARBONIC ACID one carbon and two oxygen - - - - - - - - - - - - - 19

An atom of CARBURETTED HYDROGEN one carbon and two hydrogen - - - - - - - - - - - 7

QUATERNARY COMPOUNDS.

OXY-NITRIC ACID. One atom of nitrogen + three oxygen - - - - - - - - - - - - - 26

SULPHURIC ACID. One sulphur + three oxygen - 34

ALCOHOL. Three carbon + one hydrogen - - 16

NITROUS ACID. One nitric acid + one nitrous gas - 31
ACETIC ACID. Two carbon + two water - - 26
NITRATE OF AMMONIA. One nitric acid + one ammonia + one water - - - - - - - - - 33
SUGAR. One alcohol + one carbonic acid - - 35

VII.—*Proportion of the Elements of some Combinations.*

The precise determination of the composition of neutral and other salts is of the greatest importance, not only for the facts themselves, but still more for their application in almost every species of analysis, and their influence on the general doctrines of chemistry. On this subject Berthier has lately contributed some new experiments ;* and Berard has published a valuable memoir. The muriates of barytes and silver have been examined by the former, and found to be composed as follows.

Muriate of barytes in crystals consists of

Base - - - -	64
Acid - - - -	21
Water - - - -	15
	100

Deprived of water, the same salt is composed of

Base - - - -	75.3
Acid - - - -	24.7
	100

The muriate of silver consists of

Acid - - - -	18.3
Silver - - - -	75
Oxygen - - -	6 7
	100

This determination agrees very nearly with Gay Lussac's latest experiment, quoted by Berard, *viz.*

Acid - - - -	18.03
Base - - - -	81.97
	100

M. Berard's researches† were directed chiefly to the analysis of the alkaline carbonates and sub-carbonates; but several other salts were examined in the course of the inquiry.

The saturated carbonates of potash and soda were formed by mingling the solutions of their sub-carbonates with one of sub-

* Nicholson's Journal, xxiv; 384. † Annales de Chimie, lxxi. 41.

carbonate of ammonia. The sub-carbonates of the same alkalis were formed by fusing their carbonates, a process which always affords them in an uniform state as to the proportion of their elements. The sub-carbonate of soda, it has been long known, may be obtained in crystals; and Berard confirms the fact that sub-carbonate of potash is also capable of assuming a regular form. To obtain it in this state, supertartrate of potash is to be calcined, lixiviated, and the solution evaporated to the degree necessary for forming crystals, which are to be dried by blotting-paper. When these crystals are exposed to a sufficient degree of heat, they are entirely deprived of water; but retain their carbonic acid.

The following are the proportions of the ingredients in 100 grains of the crystallized salts.

	Acid.	Base.	Water.
Carbonate of potash - -	42.01	48.92	9.07
Sub-carbonate of ditto - -	23.83	56.17	20.0
Carbonate of soda - -	49.95	29.85	20.20
Sub-carbonate of ditto - -	13.98	23.33	62.69

Setting apart the water of crystallization, M. Berard has given the following table of the composition of neutral salts, deduced from his own experiments.

Salts.	Base.	Acid.	Total.
Muriate of potash - - -	66.66	33.34	100
——— soda - - - -	57.00	43.00	100
Sulphate of barytes - - -	67.70	32.30	100
——— potash - - -	57.24	42.76	100
——— soda - - - -	47.22	52.78	100
Nitrate of potash - - -	48.64	51.36	100
Carbonate of potash - - -	53.81	46.19*	100
——— soda - - -	44.38	55.62	100
Sub-carbonate of potash - -	70.21	29.79	100
——— soda - - -	62.53	37.47	100

VIII.—*On the Combustion of different Kinds of Charcoal—the Proportions of Oxygen and Carbon in Carbonic Acid—and the Combustion of Hydrogen Gas.*

M. Saussure has lately published a memoir on this subject, which contains very ample and interesting details.† Its great length, however, will prevent me from giving more than a summary of the results of his experiments.

Plumbago, he found, when burned in oxygen gas, gives only

* Erroneously printed in the original 49.19.

† *Annales de Chimie*, lxxi. 254; Nicholson's Journal, xxvi. 161, 300.

carbonic acid and oxide of iron, without any mixture either of water or hydrogen gas. The products of this combustion establish that 100 grains of plumbago consist of 96 grains of carbon and four of iron; and that 100 grains of carbonic acid contain between 27.04 and 27.38 grains of carbon.

Next to plumbago, the purest kind of charcoal, which M. Saussure was able to procure, was that obtained by transmitting through a red-hot tube, the essential oil of rosemary. Its combustion afforded no water, and only a very minute quantity of carburetted hydrogen, too small in amount to affect the accuracy of the results. The composition of carbonic acid, deduced in this way, was 27.11 carbon and 72.89 oxygen.

The combustion of anthracite (glance-coal or stone-coal) and of charcoal of box-wood gave a product both of water and of carburetted hydrogen too considerable to allow much confidence to be placed in the results. The same substances were formed when charcoal was used, which had been employed in preparing the liquid sulphuretted hydrogen.* Hence it may be inferred that sulphur does not deprive charcoal of its hydrogen. M. Saussure is disposed to admit, with Mr. Davy, that sulphur contains both oxygen and hydrogen; the former of which, he supposes, unites with the hydrogen, while the latter combines with the carbon.

The conclusion, that oxygen gas sustains no change of volume by conversion into carbonic acid, is not impeached by these experiments. But when any of those varieties of charcoal were used, which contain hydrogen, a small increase of volume took place, if the hydrogen happened to escape unburned; and a diminution, if it was wholly consumed during the combustion.

In the course of his inquiries, M. Saussure had occasion to make some observations on several eudiometrical processes. Lime-water and even barytes water, he finds, are not adapted for removing small quantities of carbonic acid from oxygen gas; because the water of the solution acts on oxygen gas; of which it absorbs a small quantity abandoning at the same time a little nitrogen. A much better agent is the concentrated solution of potash, used over mercury, and in a quantity barely sufficient to effect the absorption.

The eudiometer of Volta, M. Saussure has found, in common with other chemists, not to be perfectly accurate. If the oxygen gas be in excess, the nitrogen which it contains, it is well known,

* See vol. i. page 267.

is apt to be condensed into nitric acid.* But it even appears, from M. Saussure's researches, that an excess of hydrogen does not insure precision; for, in this case, he has discovered that nitrate of ammonia is generated. The slow inflammation of hydrogen gas and of all the varieties of carburetted hydrogen in atmospheric air, is attended with a production of nitrate of ammonia.

Lastly, M. Saussure has added the important observation that all the varieties of hydrogen gas, even those which hitherto have been deemed quite pure, whether obtained by the solution of metals in dilute acids; by the decomposition of water by Voltaic electricity; or by passing ammonia through a red-hot tube, contain charcoal and probably even oxygen also, for they all yield carbonic acid when inflamed with an excess of oxygen gas. When there is a deficiency of oxygen, the carbon remains unconsumed; but in this case the residuary hydrogen contains a greater proportional quantity of charcoal. The purest hydrogen, that M. Saussure has been able to obtain, yielded, by combustion with a redundance of oxygen, a quantity of carbonic acid equal to three thousandths of its bulk.

IX.—*On the Tenacity of Ductile Metals.*

M. Guyton Morveau has lately made a series of experiments on the tenacity of metals, the results of which do not exactly accord with those which have been heretofore obtained. With regard to copper, platina, silver, gold, and iron, his experiments agree with the statement given by Dr. Thomson in his System of Chemistry; but with respect to other metals they differ considerably.

A wire of 0.787 of a line English in diameter of	Supported before it broke, lb. avoird. Decimal parts.
Iron	549 250
Copper	302.278
Platina	274.320
Silver	187.137
Gold	150.753
Zinc	109.540
Tin	34.630
Lead	27 621†

It has generally been stated that lead, by the process of flatting, contrary to other metals, sustains a diminution of specific gravity;

* Some good remarks on this subject by Berthollet, jun. may be consulted in Nicholson's Journal, xxv. 154.

† *Annales de Chimie*, lxxi. 189; or Nicholson's Journal, xxvi. 102.

and M. Morveau, on repeating the experiment, found it to be correct. But when the lead is prevented from escaping laterally, by stamping the metal in a very strong collar, its density was ascertained to be increased from 11.358 to 11.388.

M. Morveau has determined, also, that the purest distilled water exerts a speedy action on lead, even when the water is contained in glass vessels, so as to exclude all galvanic influence. This effect, he finds, is connected with the presence of air in water; that it ceases as soon as the water is no longer capable of furnishing air; and that it does not take place at all in water, which has been thoroughly purged of air by long boiling or by the air-pump. What is most singular, however, and would require farther experiment before it could be admitted, is, that the presence of any neutral salt, as the sulphates, nitrates, muriates, &c. even, for instance, 0.002 of sulphate of lime, is sufficient to obstruct this action both in open and covered vessels.

X.—*Properties of Nickel.*

A set of experiments on nickel have lately been made by Professor Tourte of Berlin,* in consequence of his having to prepare a needle of that metal for the Royal Mineralogical Cabinet.

The colour of nickel, he compares to that of silver of twelve deniers heated to redness. The metal takes a fine polish, and has then a lustre intermediate between that of steel and platina. When ignited, the colour is changed to that of antique bronze. The intensity of this colour increases every time the metal is heated, and a stain of oxide is left which is removed by nitric acid.—When ignited in oxygen gas, it burns and throws out sparks.

At $54\frac{1}{2}^{\circ}$ Fahrenheit M. Tourte found the specific gravity of nickel slightly hammered 8.402, and thoroughly hammered 8.932. It is ductile and tenacious, and may be drawn into the slenderest wire. It cannot easily be soldered, on account of a crust of oxide which forms on its surface. Its power of conducting heat is superior to that of either zinc or copper, with both of which it was compared.

The magnetic property of nickel is very remarkable, and is retained after being alloyed with a minute quantity of arsenic. Oxidation, however, diminishes it, even when the metal is oxidized only to such a degree as to be slightly tarnished. Heating it red-hot, for six times in succession, destroyed also its magnetic power. Its polarity, M. Tourte considers as entirely acquired, and as never existing without the previous application of a magnet.

* Nicholson's Journal xxvi. 99; or *Annales de Chime*, lxxi.

APPENDIX II.

CONSISTING OF VARIOUS USEFUL TABLES.

No. I.

CORRESPONDENCE BETWEEN ENGLISH AND FOREIGN WEIGHTS AND MEASURES.

I.—*English Weights and Measures.*

Troy Weight.

Pound.		Ounces.		Drams.		Scruples.		Grains.		Grammes.
1	=	12	=	96	=	288	=	5760	=	372 96
		1	=	8	=	24	=	480	=	31.08
				1	=	3	=	60	=	3.885
						1	=	20	=	1.295
								1	=	0.06475

Avoirdupois Weight.

Pound.		Ounces.		Drams.		Grains.		Grammes.
1	=	16	=	256	=	7000	=	453.25
		1	=	16	=	437.5	=	28.328
				1	=	27.34375	=	1.7705

Measures.

Gal.		Pints.		Ounces.		Drams.		Cub. Inches.		Litres.
1	=	8	=	128	=	1024	=	231	=	3.78515
		1	=	16	=	128	=	28 875	=	0.47398
				1	=	8	=	1.8047	=	0.02957
						1	=	0.2256	=	0.00396

N. B.—The English ale-gallon contains 282 cubical inches.

II.—*German.*

71 lbs. or grs. English troy, = 74 lbs. or grs. German apothecaries weight.

1 oz. Nuremberg, medic. weight, = 7 dr. 2. sc. 9 gr. English.

1 mark Cologne, = 7 oz. 2 dwt. 4 gr. English troy.

III.—*Dutch.*

1 lb. Dutch, = 1 lb. 3 oz. 16 dwt. 7 gr. English troy.

787½ lbs. Dutch, = 1038 lbs. English troy.

IV.—*Swedish Weights and Measures, used by Bergman and Scheele.*

The Swedish pound, which is divided like the English apothecary, or troy, pound, weighs 6556 grs. troy.

The kanne of pure water, according to Bergman, weighs 42250 Swedish grains, and occupies 100 Swedish cubical inches. Hence the kanne of pure water weighs 48088.719444 English troy grains, or is equal to 189.9413 English cubic inches; and the Swedish longitudinal inch is equal to 1.238435 English longitudinal inches.

From these data the following rules are deduced:

1. To reduce Swedish longitudinal inches to English, multiply by 1.2384, or divide by 0.80747.

2. To reduce Swedish to English cubical inches, multiply by 1.9, or divide by 0.5265.

3. To reduce the Swedish pound, ounce, dram, scruple, or grain, to the corresponding English troy denomination, multiply by 1.1382, or divide by .8786.

4. To reduce the Swedish kannes to English wine pints, multiply by .1520207, or divide by 6.57805.

5. To reduce Swedish kannes to English wine gallons, multiply by .82225 or divide by 1.216.

6. The lod, a weight sometimes used by Bergman, is the 32d part of the common Swedish pound of 16 oz. and the 24th part of the pound of 12 oz. Therefore to reduce it to the English troy pound, multiply by .03557, or divide by 28.1156.

V.—*Correspondence of English Weights and Measures with those used in France before the Revolution.*

§ 1.—WEIGHTS.

The Paris pound, *poids de marc* of Charlemagne, contains 9216 Paris grains; it is divided into 16 ounces, each ounce into 8 gros, and each gros into 72 grains. It is equal to 7561 English troy grains.

The English troy pound of 12 ounces contains 5760 English troy grains, and is equal to 7021 Paris grains.

The English avoirdupois pound of 16 ounces contains 7000 English troy grains, and is equal to 8532.5 Paris grains.

To reduce Paris grains to English troy grains, divide by - - - - - - - - } 1.2189
To reduce English troy grains to Paris grains multiply by - - - - - - - - }

To reduce Paris ounces to English troy, divide by } 1.015734
To reduce English troy ounces to Paris, multiply by }

Or the conversion may be made by means of the following tables:

1.—*To reduce French to English Troy Weight.*

The Paris pound	= 7561	English troy grains.
The ounce	= 472.5625	
The gros	= 59.0703	
The grain	= .8204	

2.—*To reduce English Troy to Paris Weight.*

The English troy pound of 12 ounces	= 7021.	Paris grains.
The troy ounce	= 585.0833	
The dram of 60 grains	= 73.1354	
The penny-weight or denier of 24 grains	= 29.2541	
The scruple of 20 grains	= 24.3784	
The grain	= 1.2189	

3.—*To reduce English Avoirdupois to Paris Weight.*

The avoirdupois pound of 16 ounces, or, 7000 troy grains	= 8538.	Paris grs.
The ounce	= 533 6250	

§. II.—LONG AND CUBICAL MEASURES.

To reduce Paris running feet, or inches, into English, multiply by	1.065977
English running feet, or inches, into Paris, divide by	
To reduce Paris cubic feet, or inches, to English, multiply by	1.211278
English cubic feet, or inches, to Paris, divide by	

Or by means of the following tables:

4.—*To reduce Paris Long Measure to English.*

The French toise = 6.3945 English feet.

The Paris royal foot of 12 inches	= 12.7977	English inches.
The inch	= 1.0664	
The line, or 1-12th of an inch	= .0888	
The 1-12th of a line	= .0074	

5.—*To reduce English Long Measure to French.*

The English foot	= 11.2596	Paris inches.
The inch	= .9383	
The 1-8th of an inch	= .1173	
The 1-10th	= .0938	
The 1-12th	= .0782	

6.—*To reduce French Cube Measure to English.*

The Paris cube foot -	= 1.211278	English cubical feet, or	2093.088384	inches.
The cubic inch	= .000700		1.211278	

7.—*To reduce English Cube Measure to French.**

The English cube foot, or cubical inches - -	1728	= 1427.4864	French cubical inches.
The cubical inch - -		= .8260	
The cube tenth - -		= .0008	

§ III.—MEASURE OF CAPACITY.

The Paris pint contains 58.145† English cubial inches, and the English wine pint contains 28.875 cubical inches; or, the Paris pint contains 2.0171082 English pints, and the English pint contains .49617 Paris pints; hence,

To reduce the Paris pint to the English, multiply by - - - - - - - - -	2.0171082
To reduce the English pint to the Paris, divide by	

The septier of Paris is 7736 French, or 9370.45 English, cubical inches; and the muid is 92832 French, or 112445.4 English, cubical inches.

* To convert the weight of a French cubic foot, of any particular substance given in French grains, into the corresponding weight of an English cubic foot in English troy grains, multiply the French grains by 0.6773181, and the product is the number of English troy grains contained in an English cubic foot of the same substance.

† It is said by Belidor, *Archit. Hydraul.* to contain 31 oz. 64 grs. of water, which makes it 58.075 English inches; but, as there is considerable uncertainty in the determinations of the weight of the French cubical measure of water, owing to the uncertainty of the standards made use of, it is better to abide by Mr. Everard's measure, which was made by the Exchequer standards, and by the proportions of the English and French foot, as established by the French Academy and Royal Society.

According to Beaume, the Paris pint contains 32 French ounces of water, at the temperature of 54.5° of Fahrenheit; which would make it equal to 59.729 English cubical inches.

VI.—*Table, showing the Comparison between French and English Grains.* (Poid de Marc.)

French grs.	=English grs.	English grs.	=French grs.
* 1	0.8203	1	1.2189
2	1.6407	2	2.4378
3	2.4611	3	3.6568
4	3.2815	4	4.8757
5	4.1019	5	6.0947
6	4.9223	6	7.3136
7	5.7427	7	8.5325
8	6.5631	8	9.7515
9	7.3835	9	10.9704
10	8.203	10	12.189
20	16.407	20	24.378
30	24.611	30	36.568
40	32.815	40	48.757
50	41.019	50	60.947
60	49 223	60	73.136
70	57.427	70	85.325
80	65.631	80	97.515
90	73.835	90	109.704
100	82.03	100	121.89
200	164.07	200	243.78
300	246.11	300	365.68
400	328.15	400	487.57
500	410.19	500	609.47
600	492.23	600	731.36
700	574.27	700	853.25
800	656.31	800	975.15
900	738.35	900	1097.04
1000	820.3	1000	1218.9
2000	1640.7	2000	2437.8
3000	2461.1	3000	3656.8
4000	3281.5	4000	4875.7
5000	4101.9	5000	6094.7
6000	4922.3	6000	7313.6
7000	5742.7	7000	8532.5
8000	6563.1	8000	9751.5
9000	7383.5	9000	10970.4
* 10,000	8203.0	10,000	12189.0

* *Per* Farey (Nicholson's Journal, xxii. 338,) 1 grain French = 0.8204 English; 10,000 ditto = 8204 ditto.

VII.—*Table, showing the Comparison between French and English Cubical Inches.*

Cubic Inches.		*Cubic Inches.*	
French = English.		English = French.	
1	1.2136	1	0.8239
2	2.4272	2	1.6479
3	3.6408	3	2.4719
4	4.8544	4	3.2958
5	6.0681	5	4.1198
6	7.2817	6	4.9438
7	8.4953	7	5.7677
8	9.7089	8	6.5917
9	10.9225	9	7.4157
10	12.136	10	8.239
20	24.272	20	16.479
30	36.408	30	24.719
40	48.544	40	32.958
50	60.681	50	41.198
60	72.817	60	49.438
70	84.953	70	57.677
80	97.089	80	65.917
90	109.225	90	74.157
100	121.36	100	82.39
200	242.72	200	164.79
300	364.08	300	247.19
400	485.44	400	329.58
500	606.81	500	411.98
600	728.17	600	494.38
700	849.53	700	576.77
800	970.89	800	659.17
900	1092.25	900	741.57
1000	1213.6	1000	823.9
2000	2427.2	2000	1647.9
3000	3640.8	3000	2471.9
4000	4854.4	4000	3295.8
5000	6068.1	5000	4119.8
6000	7281.7	6000	4943.8
7000	8495.3	7000	5767.7
8000	9708.9	8000	6591.7
9000	10922.5	9000	7415.7
10,000	12136.0	10,000	8239.0

VIII.—*New French Weights and Measures (calculated by Dr. Duncan, jun.)*

1.—*Measures of Length: the Metre being at 32°, and the Foot at 62°.*

	English Inches.	Mil.	Fur.	Yds.	Feet.	In.
Millimetre =	.03937					
Centimetre =	.39371					
Decimetre =	3.93710					
Metre =	39.37100					
Decametre =	393.71000 =	0	0	10	2	9.7
Hecatometre =	3937.10000 =	0	0	109	1	1
Kilometre =	39371.00000 =	0	4	213	1	10.2
Myriometre =	393710.00000 =	6	1	156	0	6

2.—*Measures of Capacity.*

	Cubic Inches.		*English.*			
			Tons.	Hogs.	Wine G.	Pints.
Millilitre =	.06103					
Centilitre =	.61028					
Decilitre =	6.10280					
Litre =	61.02800	=	0	0	0.	2.1133
Decalitre =	610.28000	=	0	0	2.	5.1352
Hecatolitre =	6102.80000	=	0	0	26.419	
Kilolitre =	61028.00000	=	1	0	12.19	
Myriolitre =	610280.00000	=	10	1	58.9	

3.—*Measures of Weight.*

	English Grains.		*Avoirdupois.*		
			Poun.	Oun.	Dram.
Milligramme =	.0154				
Centigramme =	.1544				
Decigramme =	1.5444				
Gramme =	15.4440				
Decagramme =	154.4402	=	0	0	5.65
Hecatogramme =	1544.4023	=	0	3	8.5
Kilogramme =	15444.0234	=	2	3	5
Myriogramme =	154440.2344	=	22	1	2

IX.—*Reduction of the Ounce Measures used by Dr. Priestley to Cubical Inches.*

Ounce Measures.	French Cubical Inches.	English Cubical Inches.
1	1.567	1.898
2	3.134	3.796
3	4.701	5.694
4	6.268	7.592
5	7.835	9.490
6	9.402	11.388
7	10.969	13.286
8	12.536	15.184
9	14.103	17.082
10	15.670	18.980
20	31.340	37.960
30	47.010	56.940
40	62.680	75.920
50	78.350	94.900
60	94.020	113.880
70	109.690	132.860
80	125.360	151.840
90	141.030	170.820
100	156.700	189.800
1000	1567.000	1898.000

X.—*Table, showing the absolute Weights and Specific Gravities of Gases, and the Quantity of each absorbed by Water.*

(Temperature 60° Fahrenheit, Barometer 30°.)

	KIND OF GAS.	Weight of 100 Cubic Inches in Eng. Grs.	Specific Gravity Standard.			No. of Cubic Inches absorbed by 100 Inches of Water.	
			Water.	Air.			
	Water		1000				
	Atmospheric air	31.	1.2279	1000	S.K.		
Simple Gases.	Oxygen gas	34.	1.35	1103	K.	37.	H.
	Ditto ditto	34.74	1.39	1127	D.		
	Azotic gas	30.535	1.21	985	K.	1.53	H.
	Ditto ditto	30.45	1.20	980	D.		
	Hydrogen gas	2.613	0.1031	84	K.	1.61	H.
Compound Combustible Gases.	Ammonia	18.16	0.715	585	K.		
	Ditto	18.	0.713	580	D.	47500.	D.
	Hydro-carburet from stagnant water	20.66		666	Dal.	1.40	H.
	Ditto from water over ignited charcoal	14.5		468	Cr.		
	Ditto from alcohol	16.		516	Cr.		
	Ditto from ether	20.		645	Cr.		
	Ditto from coal	20.2		650	Dal.		
	Phosphuretted hydrogen	26.		839	Dal.	2.14	H.
	Sulphuretted ditto	34.286	1.36	1142	K.	108.	H.
	Ditto ditto	38.17		1231	Th.		
	Olefiant gas	28.18		905	Dei.	12.5	Dal.
	Vapour of alcohol	65.*		2100	Dal.		
	Ditto of ether	70.†		2250	Dal.		
Oxides.	Carbonic oxide	30.	1.185	967	Cr.	2.01	H.
	Nitrous oxide	50.1	1.985	1615		86.	H.
	Nitric oxide	37.	1.465	1193	K.	5.	H.
	Ditto ditto	34.3	1.36	1105	D.		
Acid Gases.	Carbonic acid	46.5	1.84	1500	K.	108.	H.
	Ditto ditto	45.5	1.802	1470	D.		
	Muriatic acid	44.7?	1.765	1430	B.	51500.	T.
	Ditto ditto	59.8		1929	K.		
	Nitric acid	76.	3.	2425	D.		
	Sulphurous	70.215	2.75	2240	K.	3300.	T.

B. Brison; Cr. Cruickshank; D. Davy; Dal. Dalton; Dei. Deiman; H. Henry; K. Kirwan; S. Shuckburgh; T. Thompson; Th. Thenard.

* Of temperature 190° Fahrenheit, and force = 30 inches of mercury.

† Of temperature 100° Fahrenheit, and force = 30 inches of mercury.

XI.—*Table of the Specific Gravities of various Simple and Compound Gases.*

(Gay Lussac, *Memoires d' Arcueil*, vol. ii. p. 252.)

GASES.	Densities determined by Experiment.		Densities, calculated from the Proportion of the Elements, and their Contraction of Volume.
Atmospheric air	1.00000	Biot and Arago.	
Oxygen gas	1.10359		
Nitrogen gas	0.96913		
Hydrogen gas	0.07321		
Carbonic acid	1.5196		
Ammonia	0.59669		0.59438 (1)
Muriatic acid	1.278	Biot and G. Lussac.	
Nitrous oxide	1.61414	Davy.	
	1.36293	Berthollet.	1.52092 (2)
Nitrous gas	1.0388	Berard.	1.03636 (3)
Sulphurous acid	2.2650	Kirwan.	
Carbonic oxide	0.9569	Cruickshank.	0.96782 (4)
Steam of water	0.6896	Trales.	0.625 (5)
Oxymuriatic acid	2.470	Thenard.	2.468 (6)

(1) Supposing the contraction of the elements to be one half their total volume.

(2) The contraction of the elements being supposed equal to the whole oxygen gas.

(3) The contraction being supposed equal to half the whole volume.

(4) Supposing that 100 carbonic acid produce 100 carbonic oxide ; and lose, at the same time, 50 oxygen.

(5) Supposing the contraction equal to the volume of the oxygen gas.

(6) Supposing the condensation to be half the total volume.

XII.—*Table of the Proportions of several Compounds, whose Elements are Gaseous.*

(Gay Lussac, *Mem. d' Arcueil*, vol. ii. p. 253.

SUBSTANCES.	Proportions in volume.		Proportions in weight.	
Mur. of ammonia	100 ammon. gas	100 mūr. gas	base 38.35	acid 61.65
Neutral carbon. of ammonia	100 ditto	100 car. ac. gas	do. 28.19	do. 71.81
Sub-carbon. of do.	100 ditto	50 ditto	do. 43.98	do. 56.02
Fluobor. of do.	100 ditto	100 fluob. gas		
Sub-fluob. of do.	100 ditto	50 ditto		
Water	100 hyd. gas	50 oxygen gas	ox. 86.733	hyd. 13.267
Nitrous oxide	100 nitrogen gas	50 ditto	nit. 63.72	ox. 36.28
Nitrous gas	100 ditto	100 ditto	do. 46.757	do. 53.243
Nitric acid	100 ditto	200 ditto	do. 30.512	do. 69.488
Ditto ditto	200 nitrous gas	100 ditto	do. do.	do. do.
Nitrous acid gas	300 ditto	100 ditto	do. 34.507	do. 65.493
Ammonia	100 nitrogen gas	300 hyd. gas	do. 81.525	do. 18.475
Sulphuric acid	100 sulphs.ac.gas	50 oxygen gas	sulr. 42.016	do. 57.984
Sulphurous acid			do. 52.083	do. 47.917
Oxymur. acid gas	300 m. ac. gas	100 ditto	m. ac. 77.65	do. 22.35
100 carbon. acid	100 carb. ox. gas	50 ditto	carb. 27.376	do. 72.624
100 ditto ditto		100 ditto	do. do.	do. do.
100 carbonic oxide	50 ox. gas		carb. 42.99	do. 57.01

XIII.—*Rules for reducing the Volume of Gases to a mean height of the Barometer, and mean Temperature.*

1. *From the space occupied by any quantity of gas under an observed degree of pressure, to infer what its volume would be under the mean height of the barometer, taking this at* 30 *inches, as is now most usual.*

This is done by the rule of proportion; for, as the mean height is to the observed height, so is the observed volume to the volume required. For example, if we wish to know what space would be filled, under a pressure of 30 inches of mercury, by a quantity of gas, which fills 100 inches, when the barometer is at 29 inches,

30 : 29 : : 100 : 96.66.

The 100 inches would, therefore, be reduced to 96.66.

2. *To estimate what would be the volume of a portion of gas, if brought to the temperature of* 60° *Fahrenheit.*

Divide the whole quantity of gas by 480; the quotient will show the amount of its expansion or contraction by each degree of Fahrenheit's thermometer. Multiply this by the number of degrees which the gas exceeds, or falls below, 60°. If the temperature of the gas be above 60°, subtract, or if below 60°, add, the product to the absolute quantity of gas; and the remainder in the first case, or sum in the second, will be the answer. Thus, to find what space 100 cubic inches of gas at 50° would occupy if raised to 60°, divide 100 by 480; the quotient 0.208 multiplied by 10 gives 2.08,

which added to 100, gives 102.08 the answer required. If the temperature had been 70°, and we had wished to know the volume, which the gas would have occupied at 60°, the same number 2.08 must have been subtracted from 100, and 97.92 would have been the answer.

3. In some cases, it is necessary to make a double correction, or *to bring the gas to a mean both of the barometer and thermometer.* We must then first correct the temperature, and afterwards the pressure. Thus to know what space 100 inches of gas at 70° Fahrenheit, and 29 inches barometer, would fill at 60° Fahrenheit and 30 inches barometer, we first reduce the 100 inches, by the second process, to 97.92. Then by the first

30 : 29 : : 97.92 : 94.63.

Or 100 inches, thus corrected, would be only 94.63.

4. *To ascertain what would be the absolute weight of a given volume of gas at a mean temperature, from the known weight of an equal volume at any other temperature;* first, find by the second process what would be its bulk at a mean temperature; and then say, as the corrected bulk is to the actual weight, so is the observed bulk to the number required. Thus if we have 100 cubic inches of gas weighing 50 grains at 50° Fahrenheit, if the temperature were raised to 60° they would expand to 102.08. And

102.08 : 50 : : 100 : 49.

Therefore 100 inches of the same gas at 60° would weigh 49 grains.

5. *To learn the absolute weight of a given volume of gas under a mean pressure, from its known weight under an observed pressure,* say, as the observed pressure is to the mean pressure, so is the observed weight to the corrected weight. For example, having 100 inches of gas which weigh 50 grains under a pressure of 29 inches, to know what 100 inches of the same gas would weigh, the barometer being 30 inches,

29 : 30 : : 50 : 51.72.

Then 100 inches of the same gas, under 30 inches pressure, would weigh 51.72 grains.

6. In some cases it is necessary to combine the two last calculations. Thus, if 100 inches of gas at 50° Fahrenheit, and under 29 inches pressure, weigh 50 grains, to find what would be the weight of 100 inches at 60° Fahrenheit, and under 30 inches of the barometer, first correct the temperature, which reduces the weight to 49 grains. Then,

29 : 30 : : 49 : 50.7.

One hundred inches, therefore, would weigh 50.7 grains.

XIV.—*Specific Gravities of Solid and Liquid Substances.**

	Specific Grav.
GEMS.	
Diamond, white, oriental	3.5212
Topaz, oriental	4.0106
Sapphire, oriental	3.9941
Garnet, Bohemian	4.1888
Beryl, oriental	3.5489
Hyacinth, common	3.6873
Emerald, from Peru	2.7755
Crysolithe, from Brazil	2.6923
Amethyst, oriental	2.651
Ruby, oriental	4.2833
STONES, &c.	
Ponderous spar	4.4300
Porphyry	2.7651
Jasper, brown	2.6911
Granite, Egyptian	2.6541
Rock crystal	2.6530
Chalcedony, bright	2.6640
Carrara marble	2.7168
Alabaster, oriental	2.7302
Carnelian	2.6137
Slate, common for roofs	2.8535
Flint	2.5941
Agate, oriental	2.5901
Portland-stone	2.533
Serpentine, green, Italian	2.4295
Opal, noble	2.144
Pumice-stone	0.9145

SALTS.

	Hassenfratz.	Kirwan.	Muschenbrock.	Newton.
Potash	1.7085	4.6215		
Lime	1.5233	2.3908	2.3700	
Magnesia	0.3460	2.3298		
Alumine	0.8200	2.0000		
Barytes	2.3740	4.0000		
Sulphate of potash	2.4073	2.636	2.398	
——— alumine	1.7109		1.7260	1.714
——— zinc	1.9120		1.9	1.712
——— iron	1.8399		1.88	
——— copper	2.1943	2.23		
Nitrate of potash	1.9369	1.933	1.901	1.900
Muriate of soda	2.2001		2.0835	2.143
Acetate of lead	2.3450		2.3953	
Super-tartrate of potash	1.9153		1.8745	
Sub-borate of soda	1.7230		1.7170	1.714
Carbonate of potash	2.0120		2.749	
——— soda	1.3591	1.421		
——— ammonia	0.9660	1.8245	1.5026	

	Specific Grav.
GLASSES AND VITRIFICATIONS.	
Green bottle glass	2.7325
French crystal glass	2.8922
French mirror-glass, from St. Gobin	2.4882
English flint-glass	3.3203
China porcelain	2.3847
INFLAMMABLES.	
Roll-sulphur	1.9907
Phosphorus	1.714
Pit-coal	1.3292
Amber	1.0780
Heaviest charcoal	0.441
Mineral naphtha	0.708
Camphor	0.9887
Liquid ammonia	0.8979

* For the specific gravities of the metals, see Table of the Qualities of Metals, near the close of this Appendix.

Table of Specific Gravities of Solid and Liquid Substances,—continued.

	Specific Grav.
WATERS.	
Distilled water	1.0000
Sea-water	1.0263
Water from the Asphaltic Sea	1.2403
ACIDS.	
Sulphuric acid of commerce	1.8500
Sulphuric acid, real	2.1250
Nitric acid	1.5800
Muriatic acid	1.1940
Concentrated acetic acid	1.0626
SPIRITUOUS LIQUIDS.	
Madeira wine	1.0382
Cyder	1.0181
Brown beer	1.0338
Burgundy wine	0.9915
Champaigne wine	0.962
Brandy	0.8371
Alcohol*	0.8293
Nitric ether	0.9088
Acetic ether	0.8664
Sulphuric ether†	0.7396
Muriatic ether	0.7296
ETHEREAL OILS.	
Oil of cinnamon	1.0439
Oil of cloves	1.0363
Oil of lavender	0.8938
Spirit of turpentine	0.8697
FAT OILS.	
Linseed oil	0.9403
Poppy oil	0.9288
Oil of sweet almonds	0.9170
Olive oil	0.9153
ANIMAL FLUIDS.	
Asses' milk	1.0355
Cows' milk	1.0324
Human milk	1.0203
Human urine	1.0106
ANIMAL FATS.	
Spermaceti	0.9433
Butter	0.9423
Tallow	0.9419
Mutton suet	0.9235
Train oil	0.9235
Hogs' lard	0.9568
Ivory	1.825
Bees' wax	0.9648
GUMS.	
Common gum	1.4817
Gum Arabic	1.4523
Gum tragacanth	1.3161
GUM-RESINS.	
Asafœtida	1.3275
Scammonium, from Smyrna	1.2743
Galbanum	1.2120
RESINS.	
Guaiacum	1.2289
Jalap	1.2185
Ammoniacum	1.2071
Benzoe	1.0924
Sandarac	1.0920
White resin	1.0819
Colophony	1.0441
Mastich	1.0742
Copal, transparent	1.0452
Elastic resin	0.9335
INSPISSATED JUICES.	
Aloe *succotrina*	1.3795
Opium	1.3366
WOODS.	
Lignum guaiacum	1.3330
Box wood, Dutch	1.3280
French box wood	0.912
Ebony	1.2090
Heart of old oak	1.1700
Mahogany	1.063
Olive tree	0.9270
Mulberry tree, Spanish	0.8970
Beech tree	0.8520
Yew tree, Spanish	0.8070
Apple tree	0.7930
Plum tree	0.7850
Maple tree	0.7550
Cherry tree	0.7150
Quince tree	0.7050
Orange tree	0.7050
Walnut tree	0.6710
Pear tree	0.6610
Cypress, Spanish	0.6440
Pine tree	0.5500
White Spanish poplar tree	0.5294
Cork	0.2400

* *Per* Chaussier 0.7980. † *Per* Lovitz 0.6320.

XV.—*Rules for calculating the Absolute from the Specific Gravities of Bodies.*

In 1696, Mr. Everard, balance maker to the Exchequer, weighed before the commissioners of the House of Commons 2145.6 cubical inches, by the Exchequer standard foot, of distilled water, at the temperature of 55° of Fahrenheit, and found it to weigh 1131 oz. 14 dts. troy, of the Exchequer standard. The beam turned with 6 grs. when loaded with 30 pounds in each scale. Hence, supposing the pound avoirdupois to weigh 7000 grs. troy, a cubic foot of water weighs $62\frac{1}{2}$ pounds avoirdupois or 1000 ounces avoirdupois, wanting 106 grains troy. And hence, if the specific gravity of water be called 1000, the proportional specific gravities of all other bodies will nearly express the number of avoirdupois ounces in a cubic foot. Or, more accurately, supposing the specific gravity of water expressed by 1, and of all other bodies in proportional numbers, as the cubic foot of water weighs, at the above temperature, exactly 437489.4 grains troy, and the cubic inch of water 253.175 grains, the absolute weight of a cubical foot or inch of any body in troy grains may be found by multiplying their specific gravity by either of the above numbers respectively.

By Everard's experiment, and the proportions of the English and French foot, as established by the Royal Society and French Academy of Sciences, the following numbers are ascertained:

Paris grains in a Paris cube foot of water	= 645511
English grains in a Paris cube foot of water	= 529922
Paris grains in an English cube foot of water	= 533247
English grains in an English cube foot of water	= 437489.4
English grains in an English cube inch of water	= 253.175
By an experiment of Picard with the measure and weight of the Chatelet, the Paris cube foot of water contains of Paris grains	= 641326
By one of Du Hamel, made with great care	= 641376
By Homberg	= 641666

These show some uncertainty in measure or in weights; but the above computation from Everard's experiment may be relied on, because the comparison of the foot of England with that of France was made by the joint labour of the Royal Society of London and the French Academy of Sciences: it agrees likewise very nearly with the weight assigned by M. Lavoisier, 70 Paris pounds to the cubical foot of water.

XVI.—*Table for reducing the Degrees of Baume's Hydrometer to the Common Standard.*

Baume's Hydrometer for Liquids lighter than Water.

Temperature 55° Fahrenheit, or 10° Reaumur.

Deg.	Sp. Gr.	Deg.	Sp. Gr.	Deg.	Sp. Gr.	Deg.	Sp. Gr.
10	1.000	18	.942	26	.892	34	.847
11	.990	19	.935	27	.886	35	.842
12	.985	20	.928	28	.880	36	.837
13	.977	21	.922	29	.874	37	.832
14	.970	22	.915	30	.867	38	.827
15	.963	23	.909	31	.871	39	.822
16	.955	24	.903	32	.856	40	.817
17	.949	25	.897	33	.852		

Baume's Hydrometer for Liquids heavier than Water.

Temperature 55° Fahrenheit, or 10° Reaumur.

Deg.	Sp. Gr.	Deg.	Sp. Gr.	Deg.	Sp. Gr.	Deg.	Sp. Gr.
0	1.000	21	1.170	42	1.414	63	1.779
3	1.020	24	1.200	45	1.455	66	1.848
6	1.040	27	1.230	48	1.500	69	1.920
9	1.064	30	1.261	51	1.547	72	2.000
12	1.089	33	1.295	54	1.594		
15	1.114	36	1.333	57	1.659		
18	1.140	39	1.373	60	1.717		

XVII.—*Table, showing the Specific Gravity of Mixtures of Alcohol and Water.**

Centesimal parts of the Mixture.		SPECIFIC GRAVITIES. According to Chaussier.	According to Gilpin (last table.)
Alcohol .	100	0.7980	0.825
	95	0.8165	0.83887
	90	0.8340	0.85244
	85	0.8485	0.86414
	80	0.8620	0.87606
	75	0.87525	0.88762
	70	0.8880	0.89883
	65	0.9005	0.90941
	60	0.9120	0.91981
	55	0.9230	0.92961
	50	0.9334	0.93882
	45	0.94265	0.94726
	40	0.9514	0.95493
	35	0.95865	0.96158
	30	0.96535	0.96736
	25	0.97035	0.97239
	20	0.97605	0.97723
	15	0.9815	0.98213
	10	0.9866	0.98737
	5	0.99335	0.99327
	0	0.99835	1.00000

* Chaussier's alcohol had the specific gravity of 0.798; and Gilpin's that of 0.825. The tables of Gilpin are to be found in the Philosophical Transactions for 1794.

XVIII.—*Table, showing the Quantity of real Acid in Sulphuric Acid of different Densities.**

Real Acid *per cent.* by Weight.	Specific Gravities.	Real Acid *per cent.* by Weight.	Specific Gravities.
100	unknown	68	1.780
81	1.850	67	1.769
80	1.849	66	1.757
79	1.848	65	1.744
78	1.847	64	1.730
77	1.845	63	1.715
76	1.842	62	1.699
75	1.838	61	1.684
74	1.833	60	1.670
73	1.827	50	1.520
72	1.819	40	1.408
71	1.810	30	1.300
70	1.801	20	1.200
69	1.791	10	1.100

XIX.—*Table, showing the Quantity of pure Ammonia condensed in Solutions of different Specific Gravities.*

Specific Gravity (Water 1000.)	Grains of Ammonia in 100 Grs. of Solution.	Volume of Gas condensed.
850	35.3	494
860	32.6	456
870	29.9	419
880	27.3	382
890	24 7	346
900	22.2	311
910	19 8	277
920	17 4	244
930	15.1	211
940	12.8	180
950	10.5	147
960	8.3	116
970	6.2	87
980	4.1	57
990	2.	28

* For this and the nineteenth table, I am indebted to the obliging communication of Mr. Dalton. The table of the quantity of real acid in sulphuric acid of different densities, which has been copied from Mr. Kirwan into almost every elementary book, he finds to be deficient in accuracy. Even Mr. Davy's table of the quantity of ammonia in various solutions of that alkali, Mr. Dalton has found not to correspond exactly with his own experiments, the results of which are expressed in table XIX.

No. II.

ADMEASUREMENT AND EFFECTS OF HEAT.

I.—*Correspondence between different Thermometers.*

FAHRENHEIT's thermometer is universally used in this kingdom. In this instrument the range between the freezing and boiling points of water is divided into 180°; and as the greatest possible degree of cold was supposed to be that produced by mixing snow and muriate of soda, it was made the zero. Hence the freezing point became 32°, and the boiling point 212°.

The Centigrade thermometer places the zero at the freezing point, and divides the range between it and the boiling point into 100°. This has long been used in Sweden under the title of Celsius's thermometer.

Reaumur's thermometer, which was formerly used in France, divides the space between the freezing and boiling of water into 80°, and places the zero at the freezing point.

Wedgwood's pyrometer is only intended to measure very high temperatures. Its zero corresponds with 1077° of Fahrenheit's, and each degree of Wedgwood is equal to 130° of Fahrenheit.

De Lisle's thermometer is used in Russia. The graduation begins at the boiling point, and increases towards the freezing point. The boiling point is marked 0, and the freezing point 150.

Therefore 180° F. = 100° C. = 80° R. = 150° D. = $\frac{18}{13}$W.

1. To reduce centigrade degrees to those of Fahrenheit, multiply by 9 and divide by 5, and to the quotient add 32, that is, $\frac{\text{C.} \times 9}{5} + 32 = \text{F.}$

2. To reduce Fahrenheit's degrees to centigrade, $\frac{\text{F.} - 32 \times 5}{9} = \text{C.}$

3. To reduce Reaumur's to Fahrenheit's we have the following formula, $\frac{\text{R.} \times 9}{4} + 32 = \text{F.}$

4. To convert Fahrenheit to Reaumur, $\frac{\text{F.} - 32 \times 4}{9} = \text{R.}$

5. To reduce De Lisle's degrees under the boiling point, we

have $F. = 212 - \frac{D. \times 6}{5}$. To reduce those above the boiling point, $F. = 312 \times \frac{D. \times 6}{5}$.

6. And, inversely, to reduce Fahrenheit's degrees to De Lisle's, under the boiling point $\frac{1060 - 5\,F.}{6} = D.$; above the boiling point $\frac{F. \times 5 - 1060}{6} = D.$

7. To reduce Wedgwood's degrees to those of Fahrenheit, we have $W \times 130 + 1077 = F.$

8. Inversely, to reduce Fahrenheit to Wedgwood, $\frac{F. - 1077}{130} = W.$

Table, showing the Correspondence between the Degrees of Fahrenheit's Thermometer and the new Scale of Mr. Dalton (see vol. i. page 89.)

Fahrenheit's Scale.	Fahrenheit's Scale, corrected for the Expansion of Glass.	True equal Intervals of Temperature.
— 40.		— 175
— 21.12		— 68
— 17.06		— 58
— 12.96		— 48
— 8.52		— 38
— 3.76		— 28
+ 1.34		— 18
6.78		— 8
12.63		+ 2
18.74		12
25.21		22
32.	32.	32
39.1	39.3	42
46.6	47.	52
54.44	55.	62
62.55	63.3	72
71.04	72.	82
79.84	81.	92
89.02	90.4	102
98.49	101.1	112
108.3	110.	122
118.5	120.1	132
129.	130.4	142
139.9	141.1	152
151.	152.	162.
162.4	163.3	172
177.4	175.	182
186.5	186.9	192
199.	199.2	202
212.	212.	212
359.1		312
539.8		412
754.7		512
1000.		612
1285.		712

II.—*Table of the Effects of Heat.*

1.—*Freezing Points of Liquids.*

Fahrenheit.	
—55	Strongest nitric acid freezes (Cavendish)
46	Ether and liquid ammonia
39	Mercury
36	Sulphuric acid (Thomson)
22	Acetous acid
11	2 Alcohol, 1 water
7	Brandy
+ 1	Strongest sulphuric acid (Cavendish)
16	Oil of turpentine (Macquer)
20	Strong wines
23	Fluoric acid
	Oils bergamot and cinnamon
25	Human blood
28	Vinegar
30	Milk
32	Oxymuriatic acid
	Water
36	Olive oil
46	Sulphuric acid, specific gravity 1.78 (Keir)
64	Oil of anniseeds, 50 (Thomson)

2.—*Melting Points of Solids.*

40	Equal parts sulphur and phosphorus
82	Adipocire of muscle
97	Lard (Nicholson)
99	Phosphorus (Pelletier)
104	Resin of bile
109	Myrtle wax (Cadet)
112	Spermaceti (Bostock)
127	Tallow (Nicholson) 92 (Thomson)
149	Bees' wax
145	Ambergris (La Grange)
155	Bleached wax (Nicholson)
212	Bismuth 5 parts, tin 3, lead 2
234	Sulphur (Hope) 212 (Fourc.) 185 (Kirw.)
235	Adipocire of biliary calculi (Fourcroy)
283	Tin and bismuth, equal parts
303	Camphor
334	Tin 3, lead 2, or tin 2, bismuth 1
442	Tin (Chrichton) 413 (Irvine)
460	Tin 1, lead 4
476	Bismuth (Irvine)
612	Lead (Chrichton) 594 (Irv.) 540 (Newton)
700	Zinc
809	Antimony

Fahren.	Wedg.	
3809	21	Brass
4587	27	Copper
4717	28	Silver
5237	32	Gold
17977	130	Cobalt
20577	150	Nickel
21097	154	Soft nails
21637	158	Iron
21877	160	Manganese
23177	+170	Platina, tungsten, molybdena, uranium, titanium, &c.

3. *Solids and Liquids Volatilized.*

98	Ether boils
140	Liquid ammonia boils
145	Camphor sublimes (Venturi)
170	Sulphur evaporates (Kirwan)
176	Alcohol boils, 174 (Black)
212	Water and essential oils boil
219	Phosphorus distils (Pelletier)
230	Muriate of lime boils (Dalton)
242	Nitrous acid boils
248	Nitric acid boils
283	White arsenic sublimes
540	Metallic arsenic sublimes
554	Phosphorus boils
560	Oil of turpentine boils, about 212° (Dal.)
570	Sulphur boils
590	Sulphuric acid boils (Dalton) 546 (Black)
600	Linseed oil boils, sulphur sublimes (Davy)
660	Mercury boils (Dalton) 644 (Secondat) 600 (Black) 672 (Irvine)

4. *Miscellaneous Effects of Heat.*

—90	Greatest cold produced by Mr. Walker
50	Natural cold observed at Hudson's Bay
23	Observed on the surface of the snow at Glasgow, 1780
14	At Glasgow, 1780
0	Equal parts, snow and salt
+43	Phosphorus burns slowly
59	Vinous fermentation begins
66	to 135, Animal putrefaction
75	to 80, Summer heat in this Climate
77	Vinous fermentation rapid, acetous begins
80	Phosphorus burns in oxygen, 104 (Gottling)
88	Acetification ceases
96	to 100, Animal temperature

Fahren.	Wedg.	
107		Feverish heat
122		Phosphorus burns vividly (Fourcroy) 148 (Thomson)
165		Albumen coagulates, 156 (Black)
303		Sulphur burns slowly
635		Lowest heat of ignition of iron in the dark
800		Hydrogen burns, 1000 (Thomson)
802		Charcoal burns (Thomson)
1050		Iron red in twilight
1207	1	Iron red in daylight
1337	+2	Azotic gas burns
1857	6	Enamel colours burned
2897	14	Diamond burns (M'Kenzie) 30 W = 5000 F. (Morveau)
6277	40	Delft ware fired
8487	57	Working heat of plate glass
10177	70	Flint glass furnace
12257	86	Cream-coloured ware fired
13297	94	Worcester china vitrified
14337	102	Stone ware fired
14727	105	Chelsea china fired
15637	112	Derby china fired
15897	114	Flint glass furnace greatest heat
16007	121	Bow china vitrified
16807	124	Plate glass greatest heat
17327	125	Smith's forge
20577	150	Hessian crucible fused
25127	185	Greatest heat observed

III.—*Table of the Force of Steam at different Temperatures of Fahrenheit's Scale from actual Experiment.*

(Betancourt in Prony's Architecture Hydraulique.)

Tempera-ture.	Force in English Inches of Mercury.	Tempera-ture.	Force in English Inches of Mercury.
32	0	162	9.07
42	.08	172	11.0
52	.21	182	14.9
62	.38	192	18.7
72	.58	202	23.7
82	.87	212	29.8
92	1.26	222	37.4
102	1.74	232	46.5
112	2.37	242	57.3
122	3.16	252	69.7
132	4.16	262	83.6
142	5.43	272	97.1
152	7.00	282	108.

In the 5th volume of "Memoirs of the Manchester Society," the following valuable table of the force of vapour, for each degree of Fahrenheit, is given by Mr. Dalton; the numbers below 212° from experiment, and the higher numbers from calculation. Mr. Betancourt, however, professes to have obtained all the above results from actual experiment.

Table of the Force of Vapour from Water in every Temperature from that of the Congelation of Mercury, or 40° below zero of Fahrenheit, to 325°.

Temperature.	Force of Vapour in Inches of Mercury.	Temperature.	Force of Vapour in Inches of Mercury.	Temperature.	Force of Vapour in Inches of Mercury.
— 40	.013	37	.237	80	1.00
— 30	.020	38	.245	81	1.04
— 20	.030	39	.254	82	1.07
— 10	.043	40	.263	83	1.10
		41	.273	84	1.14
0	.064	42	.283	85	1.17
1	.066	43	.294	86	1.21
2	.068	44	.305	87	1.24
3	.071	45	.316	88	1.28
4	.074	46	.328	89	1.32
5	.076	47	.339	90	1.36
6	.079	48	.351	91	1.40
7	.082	49	.363	92	1.44
8	.085	50	.375	93	1.48
9	.087	51	.388	94	1.53
10	.090	52	.401	95	1.58
11	.093	53	.415	96	1.63
12	.096	54	.429	97	1.68
13	.100	55	.443	98	1.74
14	.104	56	.458	99	1.80
15	.108	57	.474	100	1.86
16	.112	58	.490	101	1.92
17	.116	59	.507	102	1.98
18	.120	60	.524	103	2.04
19	.124	61	.542	104	2.11
20	.129	62	.560	105	2.18
21	.134	63	.578	106	2.25
22	.139	64	.597	107	2.32
23	.144	65	.616	108	2.39
24	.150	66	.635	109	2.46
25	.156	67	.655	110	2.53
26	.162	68	.676	111	2.60
27	.168	69	.698	112	2.68
28	.174	70	.721	113	2.76
29	.180	71	.745	114	2.84
30	.186	72	.770	115	2.92
31	.193	73	.796	116	3.00
		74	.823	117	3.08
32	.200	75	.851	118	3.16
33	.207	76	.880	119	3.25
34	.214	77	.910	120	3.33
35	.221	78	.940	121	3.42
36	.229	79	.971	122	3.50

Table of the Force of Vapour, &c.—continued.

Temperature.	Force of Vapour in Inches of Mercury.	Temperature.	Force of Vapour in Inches of Mercury.	Temperature.	Force of Vapour in Inches of Mercury.
123	3.59	168	11.54		
124	3.69	169	11.83	213	30.60
125	3.79	170	12.13	214	31.21
126	3.89	171	12.43	215	31.83
127	4.00	172	12.73	216	32.46
128	4.11	173	13.02	217	33.09
129	4.22	174	13 32	218	33.72
130	4.34	175	13.62	219	34.35
131	4.47	176	13.92	220	34.99
132	4 60	177	14.22	221	35.63
133	4.73	178	14.52	222	36.25
134	4.86	179	14.83	223	36 88
135	5.00	180	15.15	224	37.53
136	5.14	181	15 50	225	38.20
137	5.29	182	15.85	226	38.89
138	5.44	183	16 23	227	39.59
139	5.59	184	16 61	228	40.30
140	5.74	185	17.00	229	41 02
141	5.90	186	17 40	230	41.75
142	6.05	187	17.80	231	42.49
143	6.21	188	18.20	232	43.24
144	6.37	189	18.60	233	44.00
145	6.53	190	19.00	234	44.78
146	6.70	191	19.42	235	45.58
147	6 87	192	19.86	236	46.39
148	7.05	193	20.32	237	47.20
149	7.23	194	20.77	238	48.02
150	7.42	195	21 22	239	48 84
151	7.61	196	21.68	240	49.67
152	7.81	197	22.13	241	50.50
153	8.01	198	22.69	242	51.34
154	8.20	199	23 16	243	52.18
155	8.40	200	23.64	244	53.03
156	8.60	201	24.12	245	53.88
157	8.81	202	24.61	246	54.68
158	9.02	203	25.10	247	55.54
159	9.24	204	25.61	248	56.42
160	9.46	205	26.13	249	57.31
161	9.68	206	26.66	250	58.21
162	9.91	207	27.20	251	59.12
163	10.15	208	27.74	252	60.05
164	10.41	209	28.29	253	61.00
165	10.68	210	28.84	254	61.92
166	10.96	211	29.41	255	62.85
167	11.25	212	30.00	256	63.76

Table of the Force of Vapour, &c.—continued.

Temperature.	Force of Vapour in Inches of Mercury.	Temperature.	Force of Vapour in Inches of Mercury.	Temperature.	Force of Vapour in Inches of Mercury.
257	64.82	280	88.75	303	115.32
258	65.78	281	89.87	304	116.50
259	66.75	282	90.99	305	117.68
260	67.73	283	92.11	306	118.86
261	68.72	284	93.23	307	120.03
262	69.72	285	94.35	308	121.20
263	70.73	286	95.48	309	122.37
264	71.74	287	96.64	310	123.53
265	72.76	288	97.80	311	124.69
266	73.77	289	98.96	312	125.85
267	74 79	290	100.12	313	127.00
268	75.80	291	101.28	314	128.15
269	76.82	292	102 45	315	129.29
270	77.85	293	103 63	316	130.43
271	78.89	294	104.80	317	131.57
272	79.94	295	105.97	318	132.72
273	80.98	296	107.14	319	133.86
274	82.01	297	108.31	320	135.00
275	83.13	298	109.48	321	136.14
276	84.35	299	110.64	322	137.28
277	85.47	300	111.81	323	138.42
278	86.50	301	112 98	324	139.56
279	87.63	302	114.15	325	140.70

IV.—*Table of the Expansion of Air by Heat.*
(Communicated by Mr. Dalton.)

Fahren.		Fahren.		Fahren.		Fahren.	
32	1000	53	1050	74	1097	95	1142
33	1002	54	1052	75	1099	96	1144
34	1004	55	1055	76	1101	97	1146
35	1007	56	1057	77	1104	98	1148
36	1009	57	1059	78	1106	99	1150
37	1012	58	1062	79	1108	100	1152
38	1015	59	1064	80	1110	110	1173
39	1018	60	1066	81	1112	120	1194
40	1021	61	1069	82	1114	130	1215
41	1023	62	1071	83	1116	140	1235
42	1025	63	1073	84	1118	150	1255
43	1027	64	1075	85	1121	160	1275
44	1030	65	1077	86	1123	170	1295
45	1032	66	1080	87	1125	180	1315
46	1034	67	1082	88	1128	190	1334
47	1036	68	1084	89	1130	200	1354
48	1038	69	1087	90	1132	210	1372
49	1040	70	1089	91	1134	212	1376
50	1043	71	1091	92	1136		
51	1045	72	1093	93	1138		
52	1047	73	1095	94	1140		

V.—*Table of the Expansion of Liquids by Heat.*

Temp.	Mercury.	Linseed Oil.	Sulphuric Acid.	Nitric Acid.	Water.	Oil of Turpentine.	Alcohol.
32°	100000	100000					100000
40	100081		99752	99514			100539
50	100183		100000	100000	100023	100000	101105
60	100304		100279	100486	100091	100460	101688
70	100406		100558	100990	100197	100993	102281
80	100508		100806	101530	100332	101471	102890
90	100610		101054	102088	100694	101931	103517
100	100712	102760	101317	102620	100908	102446	104162
110	100813		101540	103196		102943	
120	100915		101834	103776	101404	103421	
130	101017		102097	104352		103954	
140	101119		102320	105132		104573	
150	101220		102614		102017		
160	101322		102893				
170	101434		103116				
180	101526		103339				
190	101628		103587		103617		
200	101730		103911				
212	101835	107250			104577		

VI.—*Table of the Expansion of Water by Heat.*

(From Mr. Dalton's New System of Chemical Philosophy.)

Temperature.	Expansion.	Temperature.	Expansion.
12° Fahren.	100236	122° Fahren.	101116
22	100090	132	101367
32	100022	142	101638
42	100000	152	101934
52	100021	162	102245
62	100083	172	102575
72	100180	182	102916
82	100312	192	103265
92	100477	202	103634
102	100672	212	104012
112	100880		

VII.—*Table of the Expansion of Solids by Heat.*

Temp.	Platina.†	Antimon.	Steel.	Iron.	Cast Iron.	Bismuth.
32°	120000	120000	120000	120000	120000	120000
212	120104	120130	120147	120151	.	120167
White heat*			123428	121500	122571	

	Copper.	Cast Brass.	Brass Wire.	Tin.	Lead.	Zinc.
32°	120000	120000	120000	120000	120000	120000
212	120204	120225	120232	120298	120344	120355

	Hamm'd Zinc.	Zinc 8 Tin 1	Lead 2 Tin 1	Brass 2 Zinc 1	Pewter.	Copper 3 Tin‡ 1
32°	120000	120000	120000	120000	120000	120000
212	120373	120323	120301	120247	120274	120218

Expansion of Glass.

Temp.	Bulk.	Temp.	Bulk.	Temp.	Bulk.
32°	100000	100°	100023	167°	100056
50	100006	120	100033	190	100069
70	100014	150	100044	212	100083

* Rinman.

† Borda.

‡ The metal, whose expansion is here given, was an alloy composed of three parts of copper, and one of tin. The figures in some of the preceding columns are to be understood in the same manner. Thus, in the last column but two, the metal consisted of two parts of brass, alloyed with one of zinc.

VIII.—*Tables, exhibiting a collective View of all the Frigorific Mixtures, contained in Mr. Walker's Publication,* 1808.

(Communicated by Mr. Walker.)

1.—*Table, consisting of Frigorific Mixtures, having the Power of generating or creating Cold, without the Aid of Ice, sufficient for all useful and philosophical Purposes, in any Part of the World, at any Season.*

Frigorific Mixtures, without Ice.

MIXTURES.		Thermometer sinks.	Deg. of cold produced.
Muriate of ammonia	5 parts	From + 50° to + 10°	40
Nitrate of potash	5		
Water	16		
Muriate of ammonia	5 parts	From + 50° to + 4°	46
Nitrate of potash	5		
Sulphate of soda	8		
Water	16		
Nitrate of ammonia	1 part	From + 50° to + 4°	46
Water	1		
Nitrate of ammonia	1 part	From + 50° to — 7°	57
Carbonate of soda	1		
Water	1		
Sulphate of soda	3 parts	From + 50° to — 3°	53
Diluted nitric acid	2		
Sulphate of soda	6 parts	From + 50° to — 10°	60
Muriate of ammonia	4		
Nitrate of potash	2		
Diluted nitric acid	4		
Sulphate of soda	6 parts	From + 50° to — 14°	64
Nitrate of ammonia	5		
Diluted nitric acid	4		
Phosphate of soda	9 parts	From + 50° to — 12°	62
Diluted nitric acid	4		
Phosphate of soda	9 parts	From + 50° to — 21°	71
Nitrate of ammonia	6		
Diluted nitric acid	4		
Sulphate of soda	8 parts	From + 50° to 0°	50
Muriatic acid	5		
Sulphate of soda	5 parts	From + 50° to + 3°	47
Diluted sulphuric acid	4		

N. B.—If the materials are mixed at a warmer temperature than that expressed in the table, the effect will be proportionably greater; thus, if the most powerful of these mixtures be made, when the air is + 85° it will sink the thermometer to + 2°.

2.—*Table, consisting of Frigorific Mixtures, composed of Ice, with chemical Salts and Acids.*

Frigorific mixtures with Ice.

MIXTURES.		Thermometer sinks.	Deg. of cold produced.
Snow, or pounded ice	2 parts	From any temperature. to — 5°	*
Muriate of soda	1		
Snow, or pounded ice	5 parts	to — 12°	*
Muriate of soda	2		
Muriate of ammonia	1		
Snow, or pounded ice	24 parts	to — 18°	*
Muriate of soda	10		
Muriate of ammonia	5		
Nitrate of potash	5		
Snow, or pounded ice	12 parts	to — 25°	*
Muriate of soda	5		
Nitrate of ammonia	5		
Snow	3 parts	From + 32° to — 23°	55
Diluted sulphuric acid	2		
Snow	8 parts	From + 32° to — 27°	59
Muriatic acid	5		
Snow	7 parts	From + 32° to — 30°	62
Diluted nitric acid	4		
Snow	4 parts	From + 32° to — 40°	72
Muriate of lime	5		
Snow	2 parts	From + 32° to — 50°	82
Chryst. muriate of lime	3		
Snow	3 parts	From + 32° to — 51°	83
Potash	4		

N.B.—The reason for the omissions in the last column of this table is, the thermometer sinking in these mixtures to the degree mentioned in the preceding column, and never lower, whatever may be the temperature of the materials at mixing

3.—*Table, consisting of Frigorific Mixtures selected from the foregoing Tables, and combined so as to increase or extend Cold to the extremest Degrees.*

Combinations of Frigorific Mixtures.

MIXTURES.		Thermometer sinks.	Deg. of cold produced.
Phosphate of soda	5 parts	From 0° to — 34°	34
Nitrate of ammonia	3		
Diluted nitric acid	4		
Phosphate of soda	3 parts	From — 34° to — 50°	16
Nitrate of ammonia	2		
Diluted mixed acids	4		
Snow	3 parts	From 0° to — 46°	46
Diluted nitric acid	2		
Snow	8 parts	From — 10° to — 56°	46
Diluted sulphuric acid	3 }		
Diluted nitric acid	3 }		
Snow	1 part	From — 20° to — 60°	40
Diluted sulphuric acid	1		
Snow	3 parts	From + 20° to — 48°	68
Muriate of lime	4		
Snow	3 parts	From + 10° to — 54°	64
Muriate of lime	4		
Snow	2 parts	From — 15° to — 68°	53
Muriate of lime	3		
Snow	1 part	From 0° to — 66°	66
Chryst. muriate of lime	2		
Snow	1 part	From — 40° to — 73°	33
Chryst. muriate of lime	3		
Snow	8 parts	From — 68° to — 91°	23
Diluted sulphuric acid	10		

N. B.—The materials in the first column are to be cooled, previously to mixing, to the temperature required, by mixtures taken from either of the preceding tables.

IX.—*Table of the Specific Heats or Capacities of Bodies, altered from Dr. Thomson's System of Chemistry, 3d Edition.*

N. B.—The bodies compared are taken in equal weights, and the specific heat of water is assumed to be 1.

1.—GASES.

Hydrogen	21.4000	(c.)
Oxygen	4.7490	(c.)
Common air	1.7900	(c.)
Carbonic acid	1.0459	(c.)
Azote	0.7036	(c.)

2.—WATER.

Ice	0.9000	(K.)
Water	1.0000	
Steam	1.5500	(c.)

3.—SALINE SOLUTIONS.

Carbonate of ammonia	1.851	(c.)
Sulphuret of do. (0.818)	0.994	(c.)
Sulphate of magnesia 1, Water 2	0.844	(c.)
Muriate of soda 1, Water .8	0.832	(c.)
Nitrate of potash 1, Water 8	0.8167	(L.)
Ditto	0.914	(I.)
Nitrate of potash 1, Water 3	0.646	(K.)
Muriate of ammonia 1, Water 1.5	0.798	(K.)
Super-tartrate of potash 1, Water 273.3	0.765	(K.)
Sulphate of iron 1, Water 2.5	0.734	(K.)
Sulphate of soda 1, Water 2.9	0.728	(K.)
Alum 1, Water 2.9	0.649	(K.)
Nitric acid $9\frac{1}{3}$, Lime 1	0.6189	(L.)
Solution of brown sugar	1.086	(K.)

4.—ACIDS AND ALKALIS.

Nitric acid	pale	0.844	(K.)
	(1.2989)	0.6613	(L.)
		0.62	(LE.)
	(1.355)	0.570	(K.)
Muriatic acid	(1.122)	0.680	(K.)
Sulphuric acid.	(1.885)	0.758	(K.)
	(1.872)	0.429	(K.)
	do.	0.34	(LE.)
	(1.87)	0.3345	(L.)
Do. 4, Water 5		0.6631	(L.)
Do. 4, do. 3		0.6031	(L.)
Potash	(1.346)	0.759	(K.)
Ammonia	(0.997)	0.708	(K.)

5.—INFLAMMABLE LIQUIDS.

Alcohol	0.6666	(c.)
	0.64	(LE.)
	0.6024	(c.)
	1.086	(K.)
Oil of olives	0.716	(K.)
	0.500	(LE.)
Linseed oil	0.528	(K.)
Spermaceti	0.5000	(c.)
Oil of turpentine	0.472	(K.)
Spermaceti	0.399	(K.)

6.—ANIMAL FLUIDS.

Arterial blood	1.0300	(c.)
Venous blood	0.8928	(c.)
Cow's milk	0.9999	(c.)

7.—ANIMAL SOLIDS.

Ox-hide, with hair	0.7870	(c.)
Lungs of a sheep	0.7690	(c.)
Lean of ox-beef	0.7400	(c.)

8.—VEGETABLE SOLIDS.

Pinus sylvestris	0.65	(M.)
Pinus abies	0.60	(M.)
Tilea Europæa	0.62	(M.)
Pinus picea	0.58	(M.)
Pyrus malus	0.57	(M.)
Betula alnus	0.53	(M.)

(C.) Crawford; (I.) Irvine, jun.; (K.) Kirwan; (L.) Lavoisier and La Place; (LE.) Leslie; (M.) Meyer; (R.) Rumford; (W.) Wilcke;

Quercus robur sessilis	0.51	(M.)
Fraxinus excelsior	0.51	(M.)
Pyrus communis	0.50	(M.)
Rice	0.5050	(C.)
Horse beans	0.5020	(C.)
Dust of the pine tree	0.5000	(C.)
Peas	0.4920	(C.)
Fagus sylvatica	0.49	(M.)
Carpinus betulus	0.48	(M.)
Betula alba	0.48	(M.)
Wheat	0.4770	(M.)
Elm	0.47	(M.)
Quercus robur pedunculata	0.45	(M.)
Prunus domestica	0.44	(M.)
Diaspyrus ebenum	0.43	(M.)
Barley	0.4210	(C.)
Pit coal	0.2777	(C.)
Charcoal	0.2631	(C.)
Oats	0.4160	(C.)
Cinders	0.1923	(C.)

9.—EARTHY BODIES, STONE WARE, AND GLASS.

Chalk	0.2564	(C.)
Quicklime	0.2229	(C.)
	0.2168	(L.)
Ashes of pit coal	0.1855	(C.)
——— elm	0.1402	(C.)
Agate	0.195	(W.)
Stone ware	0.195	(K.)
Crystal	0.1929	(L.)
Swedish glass	0.187	(W.)
Flint glass	0.174	(K.)

10.—SULPHUR 0.183

11.—METALS.

Iron	0.125	(K.)
	0.1269	(C.)
	0.126	(W.)
Brass	0.1123	(C.)
	0.116	(W.)
Copper	0.1111	(C.)
	0.114	(W.)
Sheet iron	0.1099	(L.)
Gun metal	0.1100	(R.)
Zinc	0.0943	(C.)
	0.102	(W.)
Silver	0.082	(W.)
Tin	0.068	(K.)
	0.0704	(L.)
	0.060	(W.)
Antimony	0.086	(K.)
	0.0645	(C.)
	0.063	(W.)
Gold	0.050	(W.)
Lead	0.050	(K.)
	0.0352	(C.)
	0.042	(W.)
Bismuth	0.043	(W.)
Mercury	0.053	(K.)
	0.0357	(C.)
	0.0290	(L.)

12.—METALLIC OXIDES.

Oxide of iron	0.320	(K.)
Rust of iron	0.2500	(C.)
Do. nearly freed from air	0.1666	(C.)
White oxide of antimony washed	0.220	(K.)
	0.2272	(C.)
Do. nearly freed from air	0.1666	
Oxide of copper do.	0.2272	(C.)
Oxide of lead and tin	0.102	(K.)
Oxide of zinc	0.1369	(C.)
Oxide of tin, nearly freed from air	0.0990	(C.)
	0.096	(K.)
Yellow oxide of lead	0.0680	(C.)
	0.068	(K.)

X.—*Table of Specific Heats, from Mr. Dalton's New System of Chemical Philosophy*, Part I.*

GASES.	Equal Weights.	Equal Bulks.
Hydrogen	21.40	.002
Oxygen	4.75	.006
Common air	1.79	.002
Carbonic acid	1.05	.002
Azotic	.79	.001
Aqueous vapour	1.55	.001
LIQUIDS.		
Water	1.00	1.00
Arterial blood	1.03	
Milk (1.026)	.98	1.00
Carbonate of ammon. (1.035)	.95	.98
Carbonate of potash (1.30)	.75	.98
Solution of ammonia (.948)	1.03	.98
Common vinegar (1.02)	.92	.94
Venous blood	.89	
Solut. of common salt (1.197)	.78	.93
Solut. of sugar (1.17)	.77	.90
Nitric acid (1.20)	.76	.96
Nitric acid (1.30)	.68	.88
Nitric acid (1.36)	.63	.85
Nitrate of lime (1.40)	.62	.87
Sulph. acid and water, equal b	.52	.80
Muriatic acid (1.153)	.60	.70
Acetic acid (1.036)	.66	.70
Sulphuric acid (1.844)	.35	.65
Alcohol (.85)	.76	.65
Alcohol (.817)	.70	.57
Sulphuric ether (.76)	.66	.50
Spermaceti oil (.87)	.52	.45
Mercury	.04	.55

SOLIDS.	Eq. Wts.	Eq. Blks.
Ice	.90?	.83
Dried woods, and other vegetable substances, from .45 to	.65	
Quicklime	.30	
Pit-coal (1.27)	.28	.36
Charcoal	.26	
Chalk	.27	.67
Hydrat. lime	.25	
Flint glass (2.87)	.19	.55
Muriate of soda	.23	
Sulphur	.19	
Iron	.13	1.00
Brass	.11	.97
Copper	.11	.98
Nickel	.10	.78
Zinc	.10	.69
Silver	.08	.84
Tin	.07	.51
Antimony	.06	.40
Gold	.05	.97
Lead	.04	.45
Bismuth	.04	.40
Oxides of the metals surpass the metals themselves, according to Crawford.		

* I have added this table, though in some degree a repetition of the preceding one; because the bodies compared are taken in equal bulks, as well as in equal weights.

No. III.

I.—*Table of the Solubility of Salts in Water.*

NAMES OF SALTS.	Solubility in 100 Parts Water. At 60°	At 212°
ACIDS.		
Arsenic	150.	
Benzoic	0.208	4.17
Boracic		2.
Camphoric	1.04	8.3
Citric	133.	200.
Gallic	8.3	66.
Mucic	0.84	1.25
Molybdenic		0.1
Oxalic	50.	100.
Suberic	0.69	50.
Succinic	4.	50.
Tartaric	Very soluble	
SALIFIABLE BASES.		
Barytes	5.	50.
crystallized	57.	Unlimited
Lime	0.2	
Potash	Very soluble	
Soda	do.	
Strontites	0.6	
crystallized	1.9	50.
SALTS.		
Acetate of ammonia	Very soluble	
barytes	do.	
lime	do.	
magnesia	do.	
Acetate of potash	100.	
soda	Very soluble	
strontites		40.
Carbonate of ammonia	+ 30.	100.
barytes	Insoluble	
lime	do.	
magnesia	2.	
potash	25.	83.
soda	50.	+ 100.
strontites	Insoluble	

Table of the Solubility of Salts in Water—Continued.

NAMES OF SALTS.	Solubility in 100 Parts Water. At 60°	At 212°
SALTS.		
Camphorate of ammonia	1.	33.
barytes	0.16	
lime	0.5	
potash	33.	+ 33.
Citrate of soda	60.	
lime	Insoluble	
Hyper-oxymuriate of barytes	25.	+ 25.
mercury	25.	
potash	6.	40.
soda	35.	+ 35.
Muriate of ammonia	33.	100.
barytes	20.	+ 20.
lead	4.5	
lime	200.	
magnesia	100.	
mercury	5.	50.
potash	33.	
silver	0.$\frac{1}{30}$	
soda	35.42	36.16
strontites	150.	Unlimited
Nitrate of ammonia	50.	200.
barytes	8.	25.
lime	400.	
magnesia	100.	+ 100.
potash	14.25	100.
soda	33.	+ 100.
strontites	100.	200.
Oxalate of strontites	0.$\frac{1}{19}$	
Phosphate of ammonia	25.	+ 25.
barytes	0.	0.
lime	0.	0.
magnesia	6.6	
potash	Very soluble	
soda	25.	50.
strontites	0.	0.
Phosphate of ammonia	50.	+ 50.
barytes	0.$\frac{1}{2}$	
potash	33.	+ 33.
Sulphate of ammonia	50.	100.
barytes	0.002	
copper	25.	50.
iron	50.	+ 100.
lead	0 $\frac{1}{12}$	
lime	0.2	0.22
magnesia	100.	133.

Table of the Solubility of Salts in Water—Continued.

NAMES OF SALTS.	Solubility in 100 Parts Water. At 60°	At 212°
SALTS.		
Sulphate of potash	6.25	20.
soda	37.	125.
strontites	0.	0.02
Sulphite of ammonia	100.	
lime	0·125	
magnesia	5.	
potash	100.	
soda	25.	100.
Saccholactate of potash		12.
soda		20.
Sub-borate of soda (borax)	8.4	16.8
Super-sulphate of alumine and potash (alum)	5.	133.
potash	50.	+ 100.
Super-oxalate of potash		10.
tartrate of potash	1.$\frac{2}{3}$	3.$\frac{1}{3}$
Tartrate of potash	25.	
and soda	20.	
antimony and potash	6.6	33.

II.—*Table of Substances soluble in Alcohol.*

NAMES OF SUBSTANCES.	Temperature.	100 Parts Alcohol dissolve
Acetate of copper	176°	7.5
soda	176°	46.
Arsenate of potash	do.	3.75
soda	do.	1.7
Boracic acid	do.	20.
Camphor	do.	75.
Muriate of ammonia	do.	7.
alumine	$54\frac{1}{2}$°	100.
copper	176°	100.
iron	176°	100.
lime	do.	100.
magnesia	do.	547.
mercury		88.3
zinc	$54\frac{1}{2}$°	100.
Nitrate of ammonia	176°	89.2
alumine	$54\frac{1}{2}$°	100.
cobalt	$54\frac{1}{2}$°	100.
lime		125.
potash	176°	2.9
silver	do.	41.7
Succinic acid	do.	74.
Sugar, refined	do.	$24\frac{1}{2}$.
Super-oxalate of potash		3.
Tartrate of potash		0.04

OTHER SUBSTANCES SOLUBLE IN ALCOHOL.—All the acids, except the sulphuric, nitric, and oxymuriatic, which decompose it, and the phosphoric and metallic acids.—Potash, soda, and ammonia, very soluble. Soaps; extract; tan; volatile oils; adipocire; resins; urea.

SUBSTANCES INSOLUBLE, OR VERY SPARINGLY SOLUBLE, IN ALCOHOL.—Earths; phosphoric and metallic acids; almost all sulphates and carbonates; the nitrates of lead and mercury; the muriates of lead, silver, and soda (the last, *per* Chenevix, sparingly soluble;) the sub-borate of soda; the tartrate of soda and potash, and super-tartrate of potash; fixed oils; wax; starch; gum; caoutchouc; woody fibre; gelatine; albumen, and gluten.

III.—*Kirwan's Table, showing the Composition of Salts.*

COMPONENT PARTS.

SALTS.	BASIS.	ACID.	WATER.	STATE.
Carbonate of potash	41.	43.	16.	Crystallized.
Pearlash	60.	30.	6.	Dry.
Carbonate of soda	21.58	14.42	64.	Fully crystallized.
ditto	59.86	40.05		Dessiccated.
barytes	78.	22.		Natural or ignited.
strontian	69.5	30.		Natural or ignited.
lime	55.	45.		Natural if pure, or artificial ignited.
magnesia	25.	50.	25.	Crystallized.
common ditto	45.	34.	21.	Dried at 80°.
Sulphate of potash	54.	45.2		Dry.
soda	18.48	23.52	58.	Fully crystallized.
ditto	44.	56.		Desiccated at 700°.
ammonia	14.24	54.66	31.1	
barytes	66.66	33.33		Natural and pure, artificial ignited.
strontian	58.	42.		Natural and pure, artificial ignited.
lime	32	46.	22.	Dried at 66°.
ditto	35.23	50.39	14.38	Dried at 170°.
ditto	38.81	55.84	5.35	Ignited.
ditto	41.	59.		Incandescent.
magnesia	17.	29.35	53.65	Fully crystallized.
ditto	36.68	63.32		Desiccated.
Alum	12. ignited	17.66	51. of crystals+19.24 in the earth.	Crystallized.
Ditto	63.75	36.25		Desiccated at 700°.

Table, showing the Composition of Salts,—Continued.

COMPONENT PARTS.

SALTS.	BASIS.	ACID.	WATER.	STATE.
Nitrate of potash	51.8	44.	4.2 of Composition	Dried at 70°.
soda	40.58	53.21	6.21 of Composition	Dried at 400°.
ditto	42.34	57.55		Ignited.
ammonia	23.	57.	20.	
barytes	57.	32.	11.	Crystallized.
strontian	36.21	31.07	32.72	Crystallized.
lime	32.	57.44	10.56	Well dried, that is, in air.
magnesia	22.	46.	22.	Crystallized.
Muriate of potash	64.	36.		Dried at 80°.
soda	53.	47. aqueous, 38.88 real		Dried at 80°.
ammonia				Crystallized.
ditto	25.	42.75	32.25	Sublimed.
barytes	64.	20.	16.	Crystallized.
ditto	76.2	23.8		Desiccated.
strontian	40.	18.	42.	Crystallized.
ditto	69.	31.		Desiccated.
lime	50.	42.	8.	Red hot.
magnesia	31.07	34.59	34.34	Sensibly dry.

IV.—*Table of Incompatible Salts.**

SALTS.	INCOMPATIBLE WITH
1. Fixed alkaline sulphates	Nitrates of lime and magnesia, Muriates of lime and magnesia.
2. Sulphate of lime	Alkalis, Carbonate of magnesia, Muriate of barytes.
3. Alum	Alkalis, Muriate of barytes, Nitrate, muriate, carbonate of lime, Carbonate of magnesia.
4. Sulphate of magnesia	Alkalis, Muriate of barytes, Nitrate and muriate of lime.
5. Sulphate of iron	Alkalis, Muriate of barytes, Earthy carbonates.
6. Muriate of barytes	Sulphates, Alkaline carbonates, Earthy carbonates.
7. Muriate of lime	Sulphates, except of lime, Alkaline carbonates, Carbonate of magnesia.
8. Muriate of magnesia	Alkaline carbonates, Alkaline sulphates.
9. Nitrate of lime	Alkaline carbonates, Carbonates of magnesia and alumine, Sulphates, except of lime.

V.—*Quantity of Real Acid taken up by mere Alkalis and Earths (Kirwan.)*

100 Parts.	Sulphuric.	Nitric.	Muriatic.	Carbonic acid.
Potash	82.48	84.96	56.3	105, almost
Soda	127.68	135.71	73.41	66.8
Ammonia	383.8	247.82	171.	Variable
Baryt.	50.	56.	31.8	282.
Strontia	72.41	85.56	46.	43.2
Lime	143.	179.5	84.488	81.81
Magnesia	172.64	210.	111.35	200. Fourcroy
Alumine	150.9			335, nearly, Bergman

VI.—*Quantity of Alkalis and Earths taken up by* 100 *Parts of real Sulphuric, Nitric, Muriatic, and Carbonic Acids, Saturated (Kirwan.)*

100 Parts.	Potash.	Soda.	Ammonia	Baryt.	Strontia.	Lime.	Mag.
Sulphuric	121.48	78.32	26.05	200.	138.	70.	57.92
Nitrous	117.7	73.3	40.35	178.12	116.86	55.7	47.64
Muriatic	177.6	136.2	58.48	314.46	216.21	118.3	398.
Carbonic	95.1	149.6		354.5	231. +	122.	50.

* That is, salts which cannot exist together in solution, without mutual decomposition.

VII.—*Table, by Richter, of the Quantity of each Base required for the Saturation of the different Acids.*

(From Berthollet's *Statique Chimique*, 1re *Partie*, p. 136.

The experiments, from which the following table was deduced, we are assured by Berthollet, were the principal occupation of Richter from the year 1791 to 1800; and, from the attention with which they were performed, appear to be deserving of considerable confidence. An example will best explain the method of using the table. Take the article *potash* in the first column, opposite to which is placed the number 1605. The numbers in the other column show how much of each acid is required to saturate 1605 parts of potash, *viz.* 427 parts of fluoric acid, 577 of carbonic acid, &c. In a similar manner, take any acid in the second column, the oxalic for instance; the first column shows how much of each base effects the saturation of 755 parts of oxalic acid, *viz.* 525 of alumine, 615 of magnesia, &c.

BASES.		ACIDS.	
Alumine	525	Fluoric	427
Magnesia	615	Carbonic	577
Ammonia	672	Sebacic	706
Lime	793	Muriatic	712
Soda	859	Oxalic	755
Strontites	1329	Phosphoric	979
Potash	1605	Formic	988
Barytes	2222	Sulphuric	1000
		Succinic	1209
		Nitric	1405
		Acetic	1480
		Citric	1563
		Tartaric	1691

No. IV.

I.—*Table, showing some of the Qualities of Metals; the Proportion of Oxygen with which they combine; and the Colours of their Oxides.*

(Compiled from two of the Tables in Thomson's Chemistry.)

Metals.	Colour.	Specific Grav.	Fusing Point.	No. of Oxides.	Colours of Oxides.	Prop. of Oxyg.
Gold	Yellow	19.361	32 W.	1 2	Purple Yellow	 10.
Platina	White	23.000	+170 W.	1 2	Green Brown	.7½ 0.15
Palladium	White	11.871	+160 W.	1 2	Blue Yellow?	
Rhodium	White	+ 11	+160 W.	1 2	 Yellow	
Iridium	White		+160 W.	1 2	Blue? Red?	
Osmium	Blue			1	Transparent	
Silver	White	10.510	22 W.	1 2	 Olive	 12.8
Mercury	White	13.568	— 39 F.	1 2 3	Black Red	5. 11.
Copper	Red	8.895	27 W.	1 2	Red Black	13. 25.
Iron	Bluish-grey	7.788	158 W.	1 2 3	White Black Red	29. 31.6 45.
Tin	White	7.299	442 F.	1 2	Grey White	25. 38.8
Lead	Bluish-white	11.352	612 F.	1 2 3 4	 Yellow Red Brown	 10.6 13.6 25.
Nickel	White	8.666	+160 W	1 2	Green Black	28.

Table, showing some of the Qualities of Metals, &c.—continued.

Metals.	Colour.	Specific Grav.	Fusing Point.	No. of Oxides	Colours of Oxides.	Prop. of Oxyg.
Zinc	White	6.861	680 F.	1 2	Ylow White	13.6 25.
Bismuth	White	9.822	476 F.	1 2	 Yellow	 12.
Antimony	Grey	6.712	809 F.	1 2	White Ditto	22.7 30.
Arsenic	White	8.310	+400 F.?	1 2	White White (acid)	33. 53.
Cobalt	White	7.700	130 W.	1 2 3	Bue Green Black	
Manganese	White	6.850	+160 W.	1 2 3	White Red Black	25. 35. 66.6
Molybdena	Grey	8.600	+170 W.	1 2 3 4	Light brown Violet Blue White	 34. 50.
Tellurium	White	6.115	+612 F.	1 2	White	
Tungsten	Greyish-white	17.6	+170 W.	1 2	Black Yellow	 25.
Uranium	Grey	9.000	+170 W.	1 2	Black Yellow	5.17 28.
Titanium	Red		+170 W.	1 2 3	Blue Red White	
Chromium	White		+170 W.	1 2 3	Green Brown Red	 200.
Columbium					White	
Tantalium					White	
Cerium	White			1 2	White Red	

N. B.—The numbers, in the last column of the foregoing table, denote the quantity of oxygen with which 100 parts of each metal combine. Thus, to form the black oxide of iron, 100 parts of the metal absorb 31.6 oxygen, and afford 131.6 of an oxide, which, in 100 parts, contains 24 of oxygen.—In the column showing the fusing point, W. added to the numerals denotes the degrees of Wedgwood's pyrometer, and F. those of Fahrenheit's thermometer.

II.—*Colour of the Precipitates thrown down from Metallic Solutions, by various Re-agents.*

Metals.	Prussiated Alkalis.	Tincture of Galls.	Water impregnated with Sulphuretted Hydrogen.	Hydro-Sulphurets.
Gold	Yellowish-white	Solution turned green. Precipitate brown of reduced gold	Yellow	Yellow
Platina	No precip.; but an orange coloured one by pruss. of mercur.	Dark green becoming paler	Precipitated in a metallic state	
Silver	White	Yellowish brown	Black	Black
Mercury	White, changing to yellow	Orange yellow	Black	Brownish black
Palladium	Olive,* Deep orange.†		Dark brown	Dark brown
Rhodium	No precip.			No precip.
Iridium	No precipitate. Colour discharged.	No precipitate. Colour of solutions discharged		
Osmium		Purple, changing to deep vivid blue		
Copper	Bright reddish brown	Brownish	Black	Black
Iron { 1. Green salts 2. Red salts	White, changing to blue Deep blue	No precipitate. Black	Not precipitated	Black
Nickel	Green	Greyish white	Not precipitated	Black
Tin	White	No. precip.	Brown	Black

* Chenevix, † Wollaston.

Colour of Precipitates from Metallic Solutions, &c.—continued.

Metals.	Prussiated Alkalis.	Tincture of Galls.	Water impregnated with Sulphuretted Hydrogen.	Hydro-Sulphurets.
Lead	White	White	Black	Black
Zinc	White	No. precip.	Yellow	White
Bismuth	White	Orange	Black	Black
Antimony	White	A white oxide merely from dilution.	Orange	Orange
Tellurium	No precip.	Yellow		Blackish
Arsenic	White	Little change	Yellow	Yellow
Cobalt	Brownish yellow	Yellowish white	Not precipitated	Black
Manganese	Yellowish white	No precip.	Not precipitated	White
Chrome	Green	Brown		Green
Molybdena	Brown	Deep brown	Brown	
Uranium	Brownish red	Chocolate		Brownish yellow
Tungsten				
Titanium	Grass green with a tinge of brown	Redish brown	Not precipitated	Grass green
Columbium	Olive	Orange		Chocolate
Tantalium				
Cerium		Yellowish		Brown, becoming deep green

III.—*Table, showing the Maximum Quantity of Oxygen taken up by different Substances.*

SIMPLE COMBUSTIBLES.

100 Hydrogen unite with	597.7 Oxygen
100 Carbon	257.
100 Azote	236.
100 Muriatic acid	194.
100 Phosphorus	154.
100 Sulphur	71.3

METALS.

100 Chrome combine with	200. Oxygen
100 Manganese	66.
100 Arsenic	53.
100 Iron	45.
100 Tin	38.8
100 Antimony	30.
100 Zinc, 100 Copper, 100 Lead, 100 Tungsten	25.
100 Mercury	17.6
100 Platina	15.
100 Silver	12.8
100 Bismuth	12.
100 Gold	10.

No. V.

*Table of Simple Affinity.**

OXYGEN.			
Carbon	Iron	Sulphur	Sulphurous
Charcoal	Tin	Carbon	Acetic
Manganese	Uranium	Phosphorus	Mucic
Zinc	Molybdena	Nitrogen	Boracic
Iron	Tungsten		Nitrous
Tin	Cobalt		Carbonic
Antimony	Antimony		Prussic
Hydrogen	Nickel	SULPHUR.	Oil
Phosphorus	Arsenic	PHOSPHORUS ?	Water
Sulphur	Chrome		Sulphur
Arsenic	Bismuth	Potash	
Nitrogen	Lead	Soda	
Nickel	Copper	Iron	
Cobalt	Tellurium	Copper	BARYTES.
Copper	Platina	Tin	
Bismuth	Mercury	Lead	*Acids* Sulphuric
Caloric ?	Silver	Silver	Oxalic
Mercury	Gold	Bismuth	Succinic
Silver		Antimony	Fluoric
Arsenous acid		Mercury	Phosphoric
Nitric oxide	CARBON.	Arsenic	Mucic
Gold		Molybdena	Nitric
Platina	Oxygen		Muriatic
Carbonic oxide	Iron		Suberic
Muriatic acid	Hydrogen		Citric
White oxide of manganese		POTASH, SODA, AND AMMONIA.	Tartaric
White oxide of lead	NITROGEN.		Arsenic
			Lactic
	Oxygen	*Acids* Sulphuric	Benzoic
	Sulphur ?	Nitric	Acetic
	Phosphorus	Muriatic	Boracic
	Hydrogen	Phosphoric	Sulphurous
		Fluoric	Nitrous
		Oxalic	Carbonic
OXYGEN.†		Tartaric	Prussic
		Arsenic	Sulphur
	HYDROGEN.	Succinic	Phosphorus
Titanium		Citric	Water
Manganese		Lactic	Fixed Oils
Zinc	Oxygen	Benzoic	

* This table, it may be necessary to observe, does not express accurately the *comparative affinities* of bodies, but denotes merely the actual *order of decomposition*, which, as Berthollet has shown, may often be contrary to that of affinity, owing to the influence of various extraneous forces.

† Vauquelin's table of the affinity of the metals for oxygen, according to the difficulty with which their oxides are decomposed by heat.

Table of Simple Affinity—Continued.

STRONTITES.	MAGNESIA.	Carbonic Prussic	Tartaric Citric Lactic
Acids. Sulphuric	*Acids.* Oxalic		Succinic
Phosphoric	Phosphoric		Acetic
Oxalic	Sulphuric	SILEX.	Prussic
Tartaric	Fluoric		Carbonic
Fluoric	Arsenic	Fluoric acid	Ammonia
Nitric	Mucic	Potash	
Muriatic	Succinic		
Succinic	Nitric		
Acetic	Muriatic		OXIDE OF MERCURY.
Arsenic	Tartaric	OX. OF PLATINA.	
Boracic	Citric	—— GOLD.*	
Carbonic	Malic ?		Gallic acid
Water	Lactic	Gallic acid	Muriatic
	Benzoic	Muriatic	Oxalic
	Acetic	Nitric	Succinic
	Boracic	Sulphuric	Arsenic
LIME.	Sulphurous	Arsenic	Phosphoric
	Nitrous	Fluoric	Sulphuric
Acids. Oxalic	Carbonic	Tartaric	Mucic
Sulphuric	Prussic	Phosphoric	Tartaric
Tartaric	Sulphur	Oxalic	Citric
Succinic		Citric	Malic
Phosphoric		Acetic	Sulphurous
Mucic		Succinic	Nitric
Nitric	ALUMINE.	Prussic	Fluoric
Muriatic		Carbonic	Acetic
Suberic	*Acids.* Sulphuric	Ammonia	Benzoic
Fluoric	Nitric		Boracic
Arsenic	Muriatic		Prussic
Lactic	Oxalic		Carbonic
Citric	Arsenic	OXIDE OF SILVER.	
Malic	Fluoric		
Benzoic	Tartaric		
Acetic	Succinic	Gallic acid	OXIDE OF LEAD.
Boracic	Mucic	Muriatic	
Sulphurous	Citric	Oxalic	Gallic
Nitrous	Phosphoric	Sulphuric	Sulphuric
Carbonic	Lactic	Mucic	Mucic
Prussic	Benzoic	Phosphoric	Oxalic
Sulphur	Acetic	Sulphurous	Arsenic
Phosphorus	Boracic	Nitric	Tartaric
Water	Sulphurous	Arsenic	Phosphoric
Fixed oil	Nitrous	Fluoric	Muriatic

* Omitting the oxalic, citric, succinic, and carbonic, and adding sulphuretted hydrogen after ammonia.

Table of Simple Affinity—Continued.

Sulphurous	Muriatic	Arsenic	Tartaric
Suberic	Oxalic	Phosphoric	Mucic
Nitric	Sulphuric	Nitric	Phosphoric
Fluoric	Nitric	Succinic	Citric
Citric	Tartaric	Fluoric	Succinic
Malic	Phosphoric	Mucic	Fluoric
Succinic	Fluoric	Citric	Arsenic
Lactic	Succinic	Lactic	Lactic
Acetic	Citric	Acetic	Acetic
Benzoic	Acetic	Boracic	Boracic
Boracic	Prussic	Prussic	Prussic
Prussic	Fixed alkalis	Ammonia	Fixed alkalis
Carbonic	Ammonia		Ammonia
Fixed oils	Fixed oils		
Ammonia	Water		
		OXIDE OF ZINC.	SULPHURIC ACID. PRUSSIC.†
OXIDE OF COPPER.	OXIDE OF IRON.	Gallic	Barytes
Gallic	Gallic	Oxalic	Strontites
Oxalic	Oxalic	Sulphuric	Potash
Tartaric	Tartaric	Muriatic	Soda
Muriatic	Camphoric	Mucic	Lime
Sulphuric	Sulphuric	Nitric	Magnesia
Mucic	Mucic	Tartaric	Ammonia
Nitric	Muriatic	Phosphoric	Glucine
Arsenic	Nitric	Citric	Yttria
Phosphoric	Phosphoric	Succinic	Alumine
Succinic	Arsenic	Fluoric	Zircon
Fluoric	Fluoric	Arsenic	Metallic oxides
Citric	Succinic	Lactic	
Lactic	Citric	Acetic	
Acetic	Lactic	Boracic	
Boracic	Acetic	Prussic	
Prussic	Boracic	Carbonic	
Carbonic	Prussic	Fixed alkalis	SULPHUROUS ACID. SUCCINIC.‡
Fixed alkalis	Carbonic	Ammonia	
Ammonia			Barytes
Fixed oils		OXIDE OF ANTIMONY.	Lime
	OXIDE OF TIN.*		Potash
		Gallic	Soda
OXIDE OF ARSENIC.	Gallic	Muriatic	Strontites
	Muriatic	Benzoic	Magnesia
Gallic	Sulphuric	Oxalic	Ammonia
	Oxalic	Sulphuric	Glucine
	Tartaric	Nitric	Alumine

* Bergman places the tartaric before the muriatic.

† With the omission of all after ammonia.

‡ Ammonia should come before magnesia; and strontites, glucine, and zircon, should be omitted.

Table of Simple Affinity—Continued.

Zircon	Potash	Magnesia	Soda
Metallic oxides	Soda	Metallic oxides	Barytes
	Strontites	Glucine	Ammonia
	Lime	Alumine	Alumine
PHOSPHORIC ACID.	Magnesia	Zircon	Magnesia
CARBONIC.*	Ammonia		
	Glucine	OXALIC ACID.	FIXED OIL.
Barytes	Alumine	TARTARIC ——	
Strontites	Zircon	CITRIC ——.¶	Lime
Lime	Metallic oxides		Barytes
Potash		Lime	Potash
Soda	FLUORIC ACID.	Barytes	Soda
Ammonia	BORACIC ——‡	Strontites	Magnesia
Magnesia	ARSENIC ——‖	Magnesia	Oxide of mercury
Glucine	TUNGSTIC ——	Potash	Other metallic oxides
Alumine		Soda	Alumine
Zircon	Lime	Ammonia	
Metallic oxides	Barytes	Alumine	ALCOHOL.
Silex	Strontites	Metallic oxides	
	Magnesia	Water	Water
PHOSPHOROUS ACID.	Potash	Alcohol	Ether
	Soda		Volatile oil
Lime	Ammonia	BENZOIC ACID.	Alkaline sulphurets
Barytes	Glucine	White oxide of arsenic	
Strontites	Alumine	Potash	SULPHURETTED HYDROGEN.
Potash	Zircon	Soda	
Soda	Silex	Ammonia	Barytes
Ammonia		Barytes	Potash
Glucine	ACETIC ACID.	Lime	Soda
Alumine	LACTIC ——	Magnesia	Lime
Zircon	SUBERIC ——§	Alumine	Ammonia
Metallic oxides			Magnesia
	Barytes	CAMPHORIC ACID.	Zircon
NITRIC ACID.	Potash		
MURIATIC —.†	Soda	Lime	
	Strontites	Potash	
Barytes	Lime		
	Ammonia		

* Magnesia should stand above ammonia, and alumina and silicia should be omitted.

† Ammonia should stand above magnesia.

‡ Silex should be omitted, and, instead of it, water and alcohol be inserted.

‖ Except silex.

§ With the omission of strontites, metallic oxides, glucine, and zircon.

¶ Zircon after alumine.

POSTSCRIPT.

The printing of this work having been often delayed by my professional engagements, I am enabled to include in it a brief account of Mr. Davy's most recent discoveries. They are contained in a paper,* of which he has been so obliging as to send me a copy, and which will be published in the second part of the Philosophical Transactions for 1810.

According to the view, which had been commonly taken of the nature of muriatic and oxy-muriatic acids, the former is a simple body, and the latter a compound of that body with oxygen. Mr. Davy, from his earlier experiments, was led to modify in some degree this conclusion; and to consider the muriatic acid as a compound of a certain base with water, and the oxy-muriatic acid as a compound of the same base with oxygen. More lately, however, he has been induced by the experiments of Gay Lussac and Thenard, as well as by some of his own, made expressly for the purpose, to take a very different view of the subject. Oxy-muriatic acid he now regards as a simple or undecompounded basis; and muriatic acid as a compound of that basis with hydrogen. The facts, which are the ground work of this inference, fall chiefly under two classes: 1stly, Muriatic acid, it is alleged, can in no instance be procured from oxy-muriatic acid, without the presence either of hydrogen, or of some body capable of affording hydrogen. 2dly, When oxy-muriatic acid combines with metals or other oxidizable substances, it is contended, we have no proof, from an examination of the results, that any oxygen has been furnished to the combustible body.

Of the first class of facts the most singular is that charcoal, ignited to whiteness in oxy-muriatic acid, effects no change in it. This might be explained on either of two suppositions; *viz.* that oxy-muriatic contains no oxygen; or that the oxygen, which enters into its composition, is held by a stronger affinity than that with which charcoal attracts it. Now there are several facts which show that, under certain circumstances, the affinity of charcoal for

* Entitled "Researches on the Oxy-muriatic Acid, its Nature and Combinations; and on the Elements of Muriatic Acid, with some Experiments on Sulphur and Phosphorus."

oxygen is surpassed even by that of hydrogen. The experiment, therefore, does not decisively prove, that no oxygen is present in oxy-muriatic acid. In a subsequent part of the paper, Mr. Davy states that no decomposition of oxy-muriatic acid can be effected by electricity, a fact certainly confirming the notion of its being a simple substance.

On investigating the nature of the compounds, formed by the oxy-muriatic acid and metals, Mr. Davy was led to examine, with particular attention, that which results from the action of oxy-muriatic acid on tin. When these bodies are brought into contact, the whole of the gas is absorbed by the metal. On the commonly received theory, therefore, that the oxidation of a metal invariably precedes its solution, an oxide of tin might be looked for in the new compound; but, by the most careful experiments, Mr. Davy was not able to discover any.

Again, when oxy-muriatic acid is made to act on phosphorus, *phosphorous* or *phosphoric acid* ought to be generated; and as the latter acid is fixed in a strong heat, it might be expected to remain after igniting the product. Mr. Davy, however, found that the new compound, when saturated with ammonia, and afterwards made red-hot out of the contact of air, yielded no gaseous product whatsoever (a very singular circumstance when we consider the volatility of its ingredients.) He observed, also, that the residue manifested no traces of phosphoric acid, unless it had been previously heated in the atmosphere, and had undergone a sort of combustion.

If oxygen enter into the constitution of oxy-muriatic acid, it follows that water should be formed by its action on ammonia; and this indeed has been commonly stated to be the fact. But Mr. Davy, on repeating the process with the view of deciding this point, was not able to discover that any water was generated.

In an experiment originally made by Mr. Cruickshank, oxy-muriatic acid and hydrogen gases were found to unite after some time by simple admixture: and a condensible matter remained, which was nothing more than muriatic acid. This fact is equally well explained in two different ways; for we may either suppose that the hydrogen unites with oxygen furnished by the oxy-muriatic acid, and sets at liberty muriatic acid pre-existing in that compound; or else that the hydrogen unites with the oxy-muriatic acid, which in this view is a simple body, and that the two united form common muriatic acid. The latter explanation is the one which Mr. Davy prefers, chiefly because the presence of oxygen

in oxy-muriatic acid has not been demonstrated by other experiments.

When potassium is ignited in muriatic acid gas, hydrogen is evolved, and muriate of potash remains. But even this salt Mr. Davy is disposed to regard not as a compound of oxide of potassium (potash) with muriatic acid, but as a compound of metallic potassium with oxy-muriatic acid. In all cases, indeed, where muriatic acid gas is acted on by metals, he supposes that the oxy-muriatic acid is attracted from hydrogen by the metal, and a real oxy-muriate generated.

The vivid combustion of inflammable bodies in oxy-muriatic acid gas Mr. Davy does not admit to be a valid objection to his theory. The evolution of heat and light he deems to be no proof of oxygenation, but to arise merely from that intensity of action, which attends various combinations where the fixation of oxygen has never been suspected.

The compounds termed *hyper-oxymuriates*, which have been considered, chiefly on the suggestion of Mr. Chenevix, as containing oxy-muriatic acid united with an additional dose of oxygen, are rather, according to Mr. Davy's theory, compounds of oxy-muriatic acid with metallic oxides. Hyper-oxymuriate of potash, for example, is oxide of potassium saturated with oxy-muriatic acid, or a triple compound of oxy-muriatic acid, potassium, and oxygen; while muriate of potash is metallic potassium saturated with oxy-muriatic acid.

In this view of the subject, oxy-muriatic acid performs the same functions as oxygen. With respect to its electrical habitudes, it may be arranged in the same class with that basis; and in all analyses of its compounds by galvanic electricity, oxy-muriatic acid is evolved at the positive and hydrogen at the negative surface. In strictness, it can scarcely be deemed an acid, but rather a sort of acidifying principle.

If these striking and ingenious speculations (for such they must at present be regarded) should be confirmed by future experimental researches, material changes will be required in the existing nomenclature of chemistry; and important modifications must be made in several parts of the received theory of the science.

Another subject, to which Mr. Davy has recently directed his attention, is the action of potassium on sulphur and sulphuretted hydrogen, and on phosphorus and phosphuretted hydrogen. If potassium and sulphur be made to act on each other in glass retorts, part of the potassium, he finds, is lost by its operation on the

glass. This furnishes one reason why less sulphuretted hydrogen gas was evolved in Mr. Davy's former experiments, from a given weight of potassium combined with sulphur, than might have been expected from the quantity of hydrogen evolved by the recent metal. On repeating the experiment, no proof was gained that the potassium had acquired oxygen from the sulphur. All that can be demonstrated is a combination of potassium with sulphur, in the proportion of three of the former to one of the latter, which burns into neutral sulphate of potash. Neither did it appear that by the action of potassium on phosphorus, any effect was produced beyond the formation of a phosphuret of potassium, consisting of about three parts of phosphorus to eight of the metal.

It is remarkable that the weights of the ultimate atoms of several compounds, deduced by Mr. Davy from his own experiments, do not differ very materially from those which had been inferred by Mr. Dalton from other data. This will appear from a comparison of the following numbers with those already stated at page 328 of this volume.

The weight of an ultimate atom of	potash - - -	48.
———	potassium - -	40.5
———	oxy-muriatic acid -	32.9
———	muriatic acid -	33.9
———	phosphorus - -	16.5
———	sulphur - -	13.5

NOTES,

BY PROFESSOR SILLIMAN, OF YALE COLLEGE.

Note 32, *page* 8. *Natural History of Metals.*

The metals are not presented immediately to the hand of man, like the objects of the animal and vegetable kingdoms, but, they are, for the most part, buried in darkness, in the bowels of the earth, where they are so much disguised, by combination and mixture with other substances, that they often appear entirely unlike themselves. Hence they are acquired only by slow and painful toil, and by noxious processes, and dangerous operations; their properties and uses have been but slowly developed, and it is to be regretted, that they are the most usual instruments of human destruction, and, because they are more or less the representatives of all other kinds of property, they have been made the immediate motives, means and objects, of the most sordid passions and the most flagitious crimes.

The metals are occasionally found, in nature, in the metallic state, but, more generally, they are combined with other substances, and, in this state, they are called *ores*. A metal, in this condition, is said to be mineralized, and the substance with which it is combined, is called the mineralizer. The principal mineralizers are oxygen, sulphur, arsenic, the carbonic, sulphuric, muriatic, arsenic and phosphoric acids, and carbon. As far as our knowledge at present extends, all ores may be included under one or another of the following descriptions :

1. Native metals, and alloys of one metal with another.
2. Native metallic oxides ; or, compounds of the metals with oxygen.
3. Native metallic salts; or, compounds of the metallic oxides with acids.
4. Native sulphurets and carburets; or, compounds of the metals with sulphur or carbon.

Gold, silver, platina, mercury, copper, bismuth, antimony and arsenic are frequently found native ;—iron more rarely, and a few other metals have been reported to be found occasionally native. The native alloys exist principally bteween gold and silver, gold and copper, and mercury and silver. Arsenic, however, is a very common mineralizer, and exists, more or less, in a great proportion of the ores. Platina is always found in the metallic state;—gold, most generally, and silver frequently.

The metallic oxides and sulphurets constitute by far the most extensive and important classes of ores. In the state of oxide the metals are brittle, "have an earthy appearance and exhibit different colours, but have no lustre. Iron, cobalt, copper, arsenic, bismuth, antimony, zinc, manganese, tin, lead and mercury exist in this condition." (Schmeisser ii. 14.)

Metals, combined with sulphur, are also brittle, but they frequently have the metallic lustre. The compounds of iron and sulphur are called pyrites;

the same name is applied to compounds of sulphur and iron, containing copper, or arsenic, and the first description is called ferruginous—the second cupreous, and the third arsenical pyrites.

Heat produces in the sulphurets a sulphureous odour, and in those which contain arsenic, as many of the pyritical ores do, an odour of garlic is produced by friction, percussion and heat. Silver, iron, lead, copper, mercury and antimony are often found combined with sulphur. (Ibid.)

The only metal whose combination with carbon is well understood is iron, in the substance called plumbago.

The compounds of acids with metallic oxides are more rare than most of the preceding states; they appear differently, and some of them look much more like earthy substances than ores.

1. Iron is found combined with the sulphuric, phosphoric and carbonic acids, &c.
2. Copper with the sulphuric, carbonic, arsenic and muriatic acids, &c.
3. Lead with the sulphuric, carbonic, arsenic, chromic, molybdic and muriatic acids, &c.
4. Zinc with the sulphuric.
5. Antimony with the muriatic.
6. Silver with the sulphuric, muriatic and arsenic acids.
7. Mercury with the sulphuric and muriatic acids.
8. Cobalt with the arsenic and sulphuric acids.
9. Manganese with the carbonic and phosphoric acids.

The ores constitute but a very small portion of this globe, at least of those parts of it which have been explored. They are never found in large extended masses, like those of granite, trap and limestone, but, usually, in cavities and veins, principally in the hardest rocks. These are often divided by fissures, running through them in various directions, the two sides of which frequently tally to each other as if they had been divided by some convulsion of the globe. It is in such fissures that the veins of metal are commonly found. They usually cross the strata at right angles, and, in most instances, are perpendicular or inclined to the horizon; rarely are they horizontal. The veins do not consist entirely of ore; the greater portion of them is, for the most part, filled with some kind of stony substance different from the rock; it is commonly denominated spar, because it has often a crystalline or plated structure. Carbonate of lime, or calcareous spar, fluor spar or fluate of lime, quartz, amorphous and crystallized, and sulphate of barytes, or, ponderous spar, are the most frequent, and the latter more so than perhaps any other. The miners call these things the matrix or gangue of the particular metal; sometimes the metal is dispersed among the gangue only in specks; at other times it prevails so as to occupy a considerable part, or nearly the whole of the vein. Although ores are sometimes found in horizontal beds, in plain countries, they are most abundant in mountainous and rugged regions. Granite and the other primitive rocks rarely contain ores, but gneiss and the schistose rocks contain them in abundance; limestone, quartz and barytic spars are well stored with them; they are not abundant in whin, and serpentine very seldom affords them.

There are perhaps few subjects on which mankind are more credulous than

on that of the discovery of ores. Hence the numerous impositions practised on the ignorant and avaricious by artful and impudent knavery. It is now scarcely credible that implicit faith was once reposed in the *virgula divinitoria*, or divining rod as it was called, nor should we have expected that the British Encyclopedia would have more than countenanced a folly which the good sense of mankind has long since discarded. Mr. Price, an English writer on the Cornish mines, has very gravely informed us that; "hazle rods cut in the winter do best," and that "apple tree suckers, rods from peach trees, currants, or the oak, will answer tolerably well."—The use of these rods was, that, when poised in a particular manner in the hand, they would be attracted toward the spot of earth containing an ore. Mr. Price says that if a person with a divining rod in his hand stand with one foot advanced and a guinea beneath it, and a half-penny beneath the other foot, the rod will be drawn towards the guinea, and that if the guinea be put into the place of the half-penny, the attractions will be reversed. This art once formed a distinct profession, and the same impostors pretended to be affected with convulsions, swoonings, lethargy, &c. when reposing on ground beneath which metals lay concealed. It would hardly be proper to mention such ridiculous follies, were there not still some people in this country who have a strong leaning toward them. Much more confidence is reposed in certain indications almost equally fallacious, such as the dreary aspect of a mountain—the sterility and nakedness of a country—the blighted state of vegetation, imaginary exhalations from the ground, and many other similar things. But, when metallic grains and fragments are found dispersed among the sand of a plain, or in the bed of a river, it is reasonably concluded that they have been detached by rains from the hills, and washed down by the water; when the springs of a country are contaminated with a metalline impregnation, there can be no doubt that ores are below. Above all, when a vein of metal appears at the surface, which not unfrequently happens on the steep side of a hill, a promontory, or the bank of a river, decisive evidence is obtained.

The fortunes of men ought not to be hazarded in mining speculations without all the certainty that the nature of the case will admit of, and this can frequently be afforded by *boring*, a simple and not very expensive operation, which is worth more than all the divinations and enchantments that have ever been practised.

MINE AND MINING.

After the existence of ore is ascertained to the satisfaction of the adventurers, if the country be level, or nearly so, a pit similar to a well is sunk; it is called a shaft, and if the earth be not sufficiently compact, the sides of the shaft are supported by planks and timbers; timbers are placed horizontally also, at convenient distances, and, upon these, ladders are firmly fixed in a perpendicular position, and a plank or two laid at the foot of each for a landing place; as the shaft goes down deeper and deeper, other ladders are added, in a connected series, till the miners arrive at the ore. Having found it, they of course follow the vein; this produces another excavation, at right angles with the shaft; it is called an adit, level, or gallery. If the

mine be worked through a rock, there are, of course, natural walls, and a roof sufficiently firm; sometimes the walls of the vein are of rock, while the roof is crumbly, and it must then be supported firmly by planks and timber. As the only inducement to excavate the gallery arises from the width of the vein, the gallery varies extremely in diameter;—at one place, where the vein has failed, or become very small, it is merely a narrow passage, where the miners can do nothing more than crawl through;—at another, a man can walk erect with ease, and, at another, it becomes a wide and lofty chamber. Sometimes the gallery is intersected by another vein running off at an angle; here a new gallery may be formed, and thus the work may be indefinitely extended. A shaft is often sunk from the gallery already formed, to meet a new one below, and thus these subterranean passages are made to communicate freely with one another, and with the surface of the ground. When the mine is situated in a hilly country, it becomes easy to discharge the water, merely by continuing the galleries out, to the side of a hill; but, in a level country, the water must be raised to the surface. For this purpose, as well as for raising the ore, letting down people and implements, and for other similar objects, all the powers of mechanism are occasionally employed.

The strength of men and of animals; mills, worked by wind or water, and, above all, the steam engine, which is in general use in England, are employed to accomplish the desired object. In the Dolgoath mine in Cornwall, a steam engine is employed to raise the water. The machine there employed works a rod composed of pieces of timber; it descends more than 1000 feet into the ground, and raises the water to a superior adit, where it runs off through the side of the hill. There is another evil to which the miner is peculiarly exposed. Deadly gases, consisting chiefly of the carbonic acid gas, and some varieties of the hydrogen gases, occasionally suffocate him; and, when they are inflammable, which often happens in coal mines, they become mixed with the atmospherical oxygen; when the miners descend with lamps and candles to their work, the mixture sometimes explodes and blows the adventurers and their works into the air, or hurries them with fatal velocity along the narrow chambers of the mine. To prevent these evils, recourse is had to ventilation. When the mine is situated in the side of a hill, and the galleries are continued out to the side, a ventilation is, of course, established, because the mouth of the shaft and the outlet of the gallery are at different elevations; the air within the shaft is in winter warmer, and, in summer, colder than that above ground; thus, the two columns of air, the one of which presses at the mouth of the gallery, and the other at the bottom of the shaft, are *rarely* in equilibrio, and therefore a current is established one way or the other. It is observed, that about the equinoxes, these columns sometimes are so nearly in equipoise, (because the air without and within the earth is then very nearly of the same temperature) that the miners perceive a stagnation, and it becomes necessary to kindle a fire in order to destroy the equilibrium. When circumstances do not admit of a natural ventilation, as where shafts have been sunk in a level country, it is accomplished by maintaining at the mouth of one of the shafts a constant fire, which discharges its heated air through a

long chimney, and thus the equilibrium of the otherwise equiponderant columns of the atmosphere is destroyed, and a double current of foul air up, and of good air down is maintained. No work can be done in the mines without artificial light, which enables the miner to see where the vein is richest in ore, and there he applies his hammers, crows, levers, pick axes, wedges, and other mechanical instruments to detach it from the rock. If, however, this be very hard, it is necessary to employ the force of gun powder; indeed this is more generally necessary, and the explosions (from their happening prematurely, or from their driving fragments of the rock to a distance, and thus hitting those who imagined themselves out of danger) are not unfrequently fatal to the workmen. The great copper mine of Dolgoath, at Redruth, in Cornwall, is a fair example to illustrate most of the particulars mentioned in this sketch.

Much labour and expense are saved when the ore is so situated that direct access can be had to it by a lateral excavation in the side of a hill or mountain. Then it is necessary only to penetrate into the ground in a horizontal direction till the ore is found, and thus the same passage, which serves as an entrance, affords also a drain for the water, a gallery for the people to go in and out, and a road for the conveyance of the ore, which is transported to day light on small hand sleds or waggons, drawn along the bottom of the adit; frequently, the miners are *harnessed* to these simple machines, as they find, from experience, that they work with more ease in this way. It is not possible, however, to penetrate far into a mountain without ventilation. In pursuing the narrow passage of the gallery, the air becomes so much vitiated by the respiration of the workmen, and by the burning of their candles, that, ultimately, their lights begin to burn dimly, their breathing becomes laborious, and every thing announces imminent danger. To obviate this, either a shaft is sunk from a higher part of the hill to meet the adit, or another gallery is made at a different elevation, and the two are connected in the interior of the mountain by a shaft, and thus a ventilation is produced upon the principles already explained. In this description of mines, all the expensive and troublesome machinery calculated to raise the ore and the water, and to let down people, implements, &c. may be dispensed with, and the business is wonderfully simplified.

Of this kind of mines, the ancient and celebrated ore at Castleton, in Derbyshire, called the Owdin mine, is a fine example.

Metallurgy.

As a preliminary to the great and expensive processes for extracting metals from their ores in the large way, it is necessary to perform the same thing on a small scale, for the purpose of forming a judgement as to the profit which may be expected from the mine, and, indeed, this step ought always to be taken previously to the expenditure of any great sums in the mechanical operations of mining, otherwise, great loss may be sustained. These operations are called *docimasy* or the *docimastic* art; they constitute the assay, by which the quality and richness of the ore is judged of. The habit of examining minerals will soon enable a person, from the external appearance of an ore, to form a tolerably correct judgement of its nature and value.

The blow-pipe will prove an important aid to his judgement, for, by means of this, assisted by proper fluxes, a judgement can usually be formed, in a few minutes, as to the kind of ore, although not always as to the proportion of metal. A piece of charcoal or a spoon of platina is commonly used for a support to the bit of ore under examination, and various additions of borax—sub carbonate of soda—black or white flux, microcosmic salt, &c. are made accordiug to the object in view. The blow-pipe is admirably adapted to the almost instantaneous production of a high and very manageable heat. As examples of its use, it may be mentioned that if a minute portion of the ore of cobalt be fused with borax, a fine blue button will be formed; if the proportion of salt has been too small, the button will appear almost black, but will become blue, on being diluted with more borax and fused over again. If borax be fused with oxide of manganese, a purple button will be formed; if this button be completely surrounded by the flame of the blow-pipe, and urged with a heat continued, for a few minutes, the globule will emit bubbles of gas and will become colourless; this is owing to the escape of oxygen gas which brings the manganese to the state of white oxide when it loses its colour. If this colourless globule be heated again with the exterior flame of the blow-pipe, while the air has free contact with the globule, the purple colour will return; then by alternately repeating the first and second experiment upon it, the colour may be discharged and renewed at pleasure. Should these circumstances occur, the operator would, with good reason, conclude, that the first substance was cobalt and the second manganese. For minute instructions as to the use of the blow-pipe, reference may be had to Bergman's chemistry.

For practical purposes, the examination of ores is, however, commonly made in the assay furnace. Good, middling and poor specimens of the ore are selected, that the result may be neither too flattering nor too discouraging. The pieces selected should be as free from the matrix as possible, and the stony matter may be still farther separated by breaking it with a hammer.

The ore is then pounded and the stony matters farther picked out; and advantage is taken of the difference in specific gravity between the ore and the matrix; they are agitated in water, or a stream is suffered to pass over them, when the metallic parts will sink and the stony fragments are washed away. A convenient quantity is then taken, varying from 100 grains to 100 pounds, according to the nature and value of the ore, and the degree of precision required; this is roasted, as it is called, that is, it is exposed, for a considerable time, to a low red heat, applied in shallow vessels. The object of this operation is to expel any sulphur or arsenic, which the mineral may contain; and which it is, may be inferred from the smell, which is sulphureous in the one case, and alliaceous in the other. During this operation the metal is always converted into an oxide, and the object of the next process is to bring it to the state of a metal, by mixing it with substances which will at once promote its fusion, and abstract its oxygen. These substances are called fluxes; they are numerous and various, and different fluxes are employed in reducing different ores, but they usually contain carbon, as one ingredient, and some saline or alkaline substance; the former to abstract

oxygen and the latter to promote fusion. The most common is the black flux, formed from two parts of tartar and 1 of nitre, mixed in a red hot crucible; this is well adapted to the ores of lead, copper and antimony. Another flux, well adapted to iron ores, is composed of 20 parts of calcined borax, 10 of nitre and 2 of slacked lime, and these proportions correspond to 10 grains of the ore. Pounded glass 16 parts, borax 2, and powder of charcoal 1, answer the same purpose. Arsenic and nitre, in equal parts, form also a very active flux. With some of these, or other fluxes, a certain quantity of the roasted ore is heated in a crucible, and, at the end of the operation, the metal is found reduced, at the bottom of the crucible, forming a metallic button, whose weight, compared with that of the ore, gives the proportion of metal with sufficient accuracy to enable those concerned to decide on the expediency of prosecuting the adventure. This is however but a coarse analysis, if the object be to ascertain with correctness, the true chemical composition of the ore. But, in an economical point of view, it is, perhaps, even preferable to the more accurate methods, because it is of importance that the assay should, as much possible, resemble the metallurgic processes in the large way, which must, necessarily, be performed with cheap materials and in a coarse manner, because the expense would absorb the profits were the costly re-agents of scientific chemistry introduced into the smelting and refining furnaces.

This method of examination is *via sicca*, in the dry way, as it used to be called. But, if we would ascertain the true composition of the ore, so as to give the specimen its correct place in a system of scientific mineralogy, we must have recourse to the analysis, *via humida*, or, in the moist way, that is, not by fire, but by acids, alkalis and other re-agents. This method is now universally preferred by expert chemists, where science and not profit, is the object. Its processes however are tedious and require the utmost skill and patience in the analyst, and absolute purity in his re-agents. An account of them involves details which would be misplaced among these general remarks, and more properly belong to the history of the particular metals.

After what has been said as to the manner of assaying ores, it will not be necessary to be very minute upon the operations of metallurgy in the large way, since the principles are almost identical, and the variations in the processes are produced chiefly by a reference to economy and facility of operation. The more general operations to which the ore is subjected, are *sorting*, *stamping*, *washing*, *reducing* and *refining*.

The sorting is merely the *picking over* of the ore, to free it from the matrix and other foreign bodies. In common cases it is entrusted to women and children, but if there be several ores intermixed, which it is necessary to separate, especially if any of them be very valuable, as gold or silver, the sorting is then performed by skilful men, superintended by a master miner, or captain of the mines.

The object of the *stamping* is to reduce the ore to moderately small fragments, in order to facilitate the farther separation of the matrix. For this purpose, it is pounded in stamping mills. They consist of perpendicular cylindrical pieces of wood, shod at the foot with iron, and worked by wind

or water, or some other adequate moving power, which causes these great pestles to play up and down in huge stone troughs or mortars, containing the ore, while, in many instances, a stream of water, passing through the trough, washes away the lighter stony parts. The ore is always washed or dressed for the purpose of separating the stony fragments, and there are many ingenious means of doing this, as in the bed of a rivulet, on an artificial inclined plain, over which water is made to pass; in tubs, boxes, &c. When there are grains, or minute fragments of very valuable metal, as for instance gold, dispersed among sand, the washing is performed on inclined plains, covered with cloth, which catches the angular and small pieces, that would otherwise be washed away. When the stony matrix is very hard, it is sometimes rendered friable by heating it and throwing it, while very hot, into water, which causes it to crack.

The next object is the *roasting*. This is commonly performed in the open air, the ore being mixed with heaps of wood and exposed to a gentle red heat, a good while continued. Sometimes this operation is performed among charcoal, in furnaces of a particular form, contrived to save the arsenic or the sulphur as the case may be; they rise, in sublimation, and are condensed in some proper receptacle. Nitre is sometimes used to burn out the sulphur, but is too expensive for common use. Some ores require several repetitions of the process of roasting before they are cleared of their sulphur and arsenic.

Reduction is the next and most important operation of the whole, to which the others may be regarded as merely preparatory. This is done in furnaces which vary exceedingly in size and form, according to the particular nature of the metal and the practice of different countries.

The great object is now to separate the oxygen, that the metal may appear in its proper character. For this purpose the ore is mixed with large quantities of fuel, commonly charcoal or oak, and a strong heat is raised; the remaining sulphur and arsenic are expelled, and the oxygen, combining with the red hot carbon, flies away in the form of carbonic acid gas and gaseous oxide of carbon. Appropriate fluxes are also added to fuse any earthy matters which may remain, and sometimes lime and alkali, and even some of the less valuable metals are added to absorb the sulphur more completely. At length the metal, freed from most of its impurities, subsides to the bottom of the furnace, and the earthy and sulphurated mass floats as a scum or slag. This is sometimes drawn off at a convenient tap hole, or by rakes, or blown aside by the blast of bellows. The melted metal itself is drawn off by a tap hole at the bottom of the furnace, or, when the quantity is small, it is dipped out with ladles. The slag or scum is not always rejected. Sometimes it is rich in some other metal, which, during the operation, has been oxidized and scorified, while that which was the principal object of the process, on account of its different nature, has not suffered the same change. The slag is therefore *occasionally*, and, in some particular cases, *usually* worked over by itself, and frequently yields no contemptible product. Sometimes it is is very valuable of itself, as in the extraction of silver from lead ores, where the oxidized lead forms a slag which is the foundation of the manufacturers of litharge and red lead.

When volatile metals are to be obtained from their ores, it becomes necessary to employ a distilling apparatus, as retorts of earth or iron; mercury and zinc are metals of this description.

The metals which have been obtained by the processes of reduction, although usually sufficiently pure for commercial purposes, are rarely so in a chemical sense; they are occasionally contaminated with some of the earthy matters with which the ore has been treated, and they are often alloyed with other metals, some of which may be more valuable than the whole mass, or which impair the proper qualities of the metal.

Last of all then comes the process of Refining, the object of which is to obtain the metal absolutely pure, or at least sufficiently so to answer all the purposes for which it is wanted. As, however, the processes for refining differ exceedingly, in the cases of the different metals, it is scarcely possible to give any general account of the subject. Such details belong more properly to the history of the particular metals.

The number of the metals is now nearly thirty. Most of them are of modern discovery. The ancients were acquainted with only seven, viz. gold, silver, mercury, iron, lead, tin and copper.

Note 33, *page* 35. *Silver.*

The remark in the text, that silver, when dissolved in nitric acid exhibits a green colour if impure, is strictly applicable to the alloy of silver with copper, such as exists in coin and in trinkets, which, when dissolved in nitric acid, tinge the solution green, but silver might be impure from a combination with various other substances, without giving, on that account, a green solution. It often happens also during the action of nitric acid on metals, that a temporary green solution is obtained, owing to the generation of nitrous gas, and its transient combination with the solution; if the green colour is owing to this cause, it will disappear if the solution be heated.

Note 34, *page* 39. *Fulminating Silver.*

Pulverize 100 grains of the common lunar caustic of the shops (nitrate of silver;) add to it one ounce of alcohol and one ounce of nitric acid. If these agents are good, there will be a violent action. But this will not happen with these fluids as they are commonly found, and generally it will be necessary to apply a very moderate heat, which must be removed as soon as the action comes on. Very soon a thick white precipitate will appear; distilled water may then be thrown on to check the action if becoming too violent; the precipitate must be washed in distilled water, after having been separated by the filter, or by decantation, and will fulminate powerfully by heat or friction. A convenient way of exploding it is to place a grain or two of it on the blade of a knife, and to hold it over a candle. This process I believe was substantially suggested by Descotils, and the fulminating silver produced in this manner is, compared with that of Berthollet, a harmless preparation. Still, it is sufficiently critical and violent to render great care necessary in its preparation. Having been, for several years, accustomed to prepare it, and having never met with any accident, I had probably come, by degrees, to undervalue the danger, and, in conse-

quence incurred a serious injury, which had well nigh deprived me of my eyes; the mention of the manner in which it occurred, may perhaps save some person from a similar accident. The usual mixture of lunar caustic, alcohol and nitric acid, being made in a porcelain dish, I ventured to take it up and stir it with a glass rod, to accelerate the action, which was rather languid, and as no mischief happened from this step, which I had never ventured on before, I stirred it again, and, as some part of the nitrate adhered to the dish, a little pressure was used to detach it, when the whole exploded into my eyes with great violence, and threw me into immediate blindness, both from the mechanical force of the explosion, and from the corrosive action of the chemical agents. After some weeks of suffering and darkness, my sight was gradually restored, although the strength of the organs has never been fully regained. I have prepared the fulminating silver repeatedly since, without any accident. (For a more particular account, see Bruce's Journal, Vol. I. page 163.)

Note 35, *page* 61. *Sulphuret of Iron.*

There can be no doubt that the author perfectly understood that the phenomenon of the extrication of latent caloric, attended by light, during the combination of sulphur and iron, is not, as he has termed it, a *combustion.* Were it a real combustion, the iron would be found oxidized, and the sulphur acidified. But neither of these facts is so. It is well known that the compound decomposes water by the aid of an acid, and sulphur rises dissolved in the hydrogen, both of which facts are inconsistent with a previous combustion. Whatever uncertainty there may be (and it is acknowledged there is much) in the use of the word combustion, it must, no doubt, in every case, include a combination of oxygen with the body burned, and an increase of weight in the sum of the products, neither of which facts exists in this case.

Note 36, *page* 65.

METEORIC STONES.

The falling of stones from the atmosphere, is now universally admitted, not only by philosophical men, but, such a mass of evidence has been accumulated on the subject, that both the knowledge and belief of these events have become general.

The phenomenon is usually connected with the appearance of luminous meteors, or fire balls. Their apparent diameter is sometimes as large as the moon;* "from the main body, frequently extends a flame or train. Streams and sparkles of fire seem to shoot out on every side. Just before their disappearance, there is a violent explosion, by which pieces often appear to be detached, and thrown to the ground."

"When the stones have fallen in the *day* time, the meteor has not always been observed; probably, because its light was not sufficiently strong to draw the attention of persons abroad, to that part of the heavens, in which it was moving. But, even in this case, the same kind of *report* has

* See Professor Day's view of theories on this subject. (Memoirs of Connecticut Academy, Vol. I. Part I. page 164.)

been heard, as that which usually follows the explosion of a meteor. In many instances, the luminous body has been seen to come forward to the zenith, and apparently to burst; and, immediately after, the stones have fallen, with a whizzing noise, to the ground."

Meteors of this kind are seen, in some parts of the world, almost every year, and the same meteor is often seen over a great extent of country; in some instances, a hundred miles in breadth, and five hundred in length. (Day's view.)

Their perpendicular altitude during the time in which they are visible is calculated to be from 20 to 100 miles; and their diameter is, in some cases, estimated to be at least half a mile.

Their velocity cannot be less than 300 miles in a minute.

It has not been ascertained that these meteors do, in every instance, project stones to the ground; but stones have been observed to descend in so many instances immediately after the explosion of meteors, as sufficiently to establish the point that the stones do proceed from the meteor, and it may be presumed that, in numerous instances, they have fallen into the water, or other inaccessible places, or been effectually concealed, by being buried in the ground, in consequence of the violence of their descent.

The number of well authenticated instances in which stones have fallen from the atmosphere is now so great, that instead of attempting to enumerate them all, we shall make a selection of the most important only.

There have been traditionary and historical accounts of the falling of bodies from the heavens, from very remote antiquity. Sometimes they were regarded as objects of idolatrous worship; such was the το διοπετους (or that which fell down from Jupiter) of the Ephesians.

Livy mentions a shower of stones at Rome, under Tullus Hostilius, and a similar event is recorded to have happened there under the Consuls C. Martius and M. Torquatus. Pliny mentions a shower of iron in Lucania, the year before the defeat of Crassus, and that a very large stone fell in Thrace, in the 78th Olympiad, and three large stones are asserted to have fallen in the same country, about 452 years before Christ.* These and other similar assertions in ancient history were uniformly regarded, by the moderns, as instances of falsehood, or of excessive credulity and superstition; but they are now treated with more respect, and little doubt remains in the minds of men of science, that stones have fallen in every age of the world.

On the 7th of June, 1492, a large stone, weighing 260 pounds, fell at Ensisheim, in Upper Alsace, in France; it was preserved, till within a few years past, in a church, and was regarded as a sacred object. It fell in a storm, when the heavens appeared to be on fire, and after a loud report like a clap of thunder.

About 120 stones, among which was one of 120 and another of 60 pounds weight, fell near Padua, in the year 1510.

In 1627, the great astronomer Gassendi saw a burning stone of 59 pounds fall on Mount Vaiser, near the city of Nice, in France.

* Many of the facts stated in this abstract are taken from a table drawn up by Mr. Izarn, and which may be found in the Phil. Mag. XV. 182, and Thomson's Chemistry, second edition, Vol. III. page 419.

In 1706, a stone of 72 pounds fell, near Sarissa, in Macedonia.

In 1750, a stony mass fell at Niort, in Normandy.

In July, 1753, there was a shower of stones at Plann, near Tabor, in Bohemia; and, in September, two stones, weighing 20 pounds, fell at Siponas, in Bresse; and still another instance occurred in the same year, in the Eichstadt country, in Germany. A labourer at a brick kiln, when the ground was covered with snow, saw a body fall immediately after a violent report like thunder. He ran to the spot, but the stone still retained so much heat, that it could not be handled. It was about six inches in diameter.

In 1762, two stones, of 200 and 300 pounds, fell near Verona.

"On the 13th of September, 1768, a tempestuous cloud was seen near the castle of Sucé, in Main. From this was heard an explosion like thunder; but, without the appearance of lightning, and, directly after, a remarkable whizzing noise in the air. A number of travellers, looking up, saw an opake body descend in a curve line, and fall at a distance from them. They all ran to the place, and found a kind of stone half buried in the ground, and too hot to be touched." (Professor Day's Discourse.)

In the same year a stone fell at Aire, in Artois, and another at Le Cotentin.

A shower of stones fell at Barboutan, near Roquefort, in July 1789.

July 24, 1790, there was an extensive shower of stones in the environs of Agen.*

June 16, 1794, about 7 o'clock, P. M. at Sienna, in Italy, a tremendous cloud came from the north, sending forth sparks like a rocket, burning, and smoking like a furnace, producing violent explosions, and casting down stones to the ground. The cloud was very high. The stones, which were about twelve in number, fell at the feet of several persons.

December 13, 1795, near the Wold Cottage, in Yorkshire, England, unusual noises, like distant reports of pistols or guns, and also a *whizzing*, were heard in the air; there was no thunder or lightning. A labourer saw a body descend and strike the ground; several persons went immediately to the spot, and found an extraordinary stone, weighing 56 pounds, buried 21 inches in the earth. It was warm, smoked, and smelt strongly of sulphur.

February 19, 1796, a stone of 10 pounds fell in Portugal.

March 12, 1798, one of 20 pounds fell at Sales, near Ville Franche, and, on the 17th of the same month and year, another, of the same weight, at Salé, Department of the Rhone.

December 19, (same year,) about 8 o'clock, in a clear serene evening, a large fire ball was seen at Benares, in Bengal; it was attended by a loud noise like thunder, or a discharge of musquetry, and a shower of stones fell in a neighbouring field, and buried themselves about 6 inches deep.

April 26, 1802, about 1 o'clock, P. M. near L'Aigle, in Normandy, a very brilliant fiery globe was seen to move very rapidly through the atmosphere. Immediately after, a violent explosion, which lasted five or six

* A stone is preserved in the museum of Bordeaux, which, in 1789 or 1790, fell through the roof of a cottage, and killed a herdsman and some cattle.

minutes, was heard at the distance of 30 leagues, in every direction from L'Aigle. The sky was serene and calm, and there were only a few light clouds. A shower of stones fell in various parts of a district 7 miles in length, and 2 or 3 in breadth; the largest stone weighed 17 pounds, and the whole number was thought to be two or three thousand. One of them (presented by Col. Gibbs,) is preserved in the cabinet of Yale College.

One of the most remarkable occurrences of the kind on record happened at Weston, in Connecticut, on the 14th of December, 1807. Just after the dawn, a luminous meteor, or fire ball, apparently one half or two thirds as large as the moon, rose from the horizon in the north, and proceeded with great velocity, and a waving motion, nearly to the zenith; it was distinctly visible, through the clouds which partly covered the sky, appearing like the sun in a mist, and, when it passed the spots of clear sky, it flashed, with a vivid light, on the beholders, sparkled like a fire brand carried rapidly against the wind, discovered a waving conical train or tail of paler light; and, at length, with three loud and distinct explosions, like those of cannon, with as many leaps, and a rapid succession of fainter reports, like those of musketry, and a decay of light somewhat gradual, disappeared. This meteor was seen from Vermont to the city of New-York, and over an extent of two or three hundred miles from New-Jersey, to Salem in Massachusetts. Masses of stone were projected from it, at each of the three principal explosions; they were scattered over an extent of ten miles in length, and three or four in breadth. One mass fell within a few yards of a man who was standing at his door; it was dashed to pieces on a rock; a piece as large as a goose egg remained unbroken, and was warm half an hour after the fall. A stone of 35 pounds fell in a door yard within a few feet of the house; it buried itself completely in the ground, at the depth of two feet. Two other stones, one of about 8 or 10 pounds, and the other of 13 pounds, fell in the fields near the same house. Two miles south, two other stones fell, one at the foot of Tashowa hill, and the other upon it; the former weighed about 20 pounds, and the latter 36 1-2 pounds; they made deep holes in the ground. At the last explosion, a mass of stone was projected, which must have weighed at least 200 pounds; it descended with a roaring noise, and a visible curve of light; struck a rock with a great concussion, dashed it, and was itself dashed in pieces, tearing a hole in the ground, on to which it glanced, of 5 feet long, 3 feet deep, and 4 1-2 wide. In all the instances there was a whizzing or roaring noise in the air, when the stones descended, and an evident concussion of the ground, when they struck. All the most important facts were witnessed by numbers of people, who never before heard of the falling of stones from the atmosphere.

Since this event, a large stone of between one and two hundred pounds weight has fallen in Russia, and, on the whole, there is much reason to believe that similar events occur almost every year, and probably have occurred from the remotest ages.

There is such a wonderful similarity in the appearance and composition of these stones, that they are completely different from any other, and yet so similar to one another, that they are readily recognized by the eye of

even a careless observer. Those which have fallen in the remotest countries, in the East Indies, in Europe, and America, are almost precisely alike in their external appearance, and chemical constitution.

Where they have not been too much broken to admit of its being observed, they are covered externally with a black crust, rough like shagreen, and proceeding, in all probability, from the effects of heat, in producing an oxygenizement and vitrification of the metallic and earthy substances. In their form, they are irregular, but they often exhibit spherical and commonly curvilinear figures. When they first fall, they often smell of sulphur, and are found to be hot if immediately examined. When broken, four distinct sorts or forms of substances may be discovered in them, either by the naked eye, or by the microscope.

1. Globular and spherical bodies, of a dark brown, or gray colour, hard enough to scratch glass, and to give a few faint sparks with steel; easily breaking under the hammer, and of a compact texture. They are of every size, from that of a grain of sand, to that of a pea. They lie imbedded in the mass of stone which appears generally of an ash gray, or light slate colour.

2. There are numerous and often highly brilliant points of pyrites of a redish yellow colour, very friable, and, when powdered, appearing black.

3. Portions of iron in the metallic state, dispersed promiscuously, like the pyrites, through the stone, and varying in size, from mere points to the magnitude of an inch or more.

4. The basis of the whole stone, that which connects all the other substances, and from which they may be detached by the point of a knife, is a granular earthy matter of an ash-gray colour, often inclining to slate, easily pulverized by the hammer and pestle, and, when in small pieces, without much difficulty between the fingers. There is, of course, a considerable variety in the distribution and proportion of the constituent substance, in the earthy cement, and, when it has been wet, spots of iron rust often appear upon the surface. The specific gravity varies from 3.352 to 4.281.

In the stones which fell at Weston, there was a considerable variety in the appearance of the earthy cement; some parts of it were light coloured, almost white, and of regular forms, as if those parts had once been a crystallized substance. In the composition of these stones there is such a surprising coincidence, as, in connection with their physical characters, and the phenomena which attend their appearance, must render it in the highest degree probable that they have a similar origin. According to Mr. Howard, a stone, which fell at Benares, consisted, in its different parts, of the following ingredients:

The pyrites contained,	2.0	sulphur,
	10.5	iron,
	1.0	nickel,
	2.0	earths, and foreign bodies.
	15.5	

The spherical bodies,
- 50.0 silex,
- 15.0 magnesia,
- 34.0 oxide of iron,
- 2.5 oxide of nickel.

107.5

The earthy cement,
- 48.0 silex,
- 18.0 magnesia,
- 34.0 oxide of iron,
- 2.5 oxide of nickel.

The stone of Yorkshire, when deprived as much as possible of metallic masses, gave Mr. Howard the following proportions in 150 grains:

75 silex,
37 magnesia,
48 oxide of iron,
2 oxide of nickel.

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The increase of weight was occasioned by the addition of oxygen to the metals.

The stones of L'Aigle yielded to Vauquelin and Fourcroy:

54 silex,
36 oxide of iron,
9 magnesia,
3 oxide of nickel,
2 sulphur,
1 lime.

105

The stone of Ensisheim gave the same analysts:

56.0 silex,
30.0 oxide of iron,
12.0 magnesia,
2.4 nickel,
3.5 sulphur,
1.4 lime.

105.3

The stones which fell at Weston, in 1807, gave, according to my analysis,

51.5 silex,
38. oxide of iron,
13. magnesia,
1.5 oxide of nickel,
1. sulphur.

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Thus we see that the stones consist, invariably, of silex, iron, magnesia, nickel, and sulphur; the silex constitutes generally about one half;—the

iron from a quarter to a third, and sometimes more; the magnesia from a tenth to a sixth, and that the sulphur and nickel are in very small proportion.

The lime mentioned in two of the analyses is probably accidental, and the existence of chrome has been asserted by Laugier, but this has not been confirmed by other chemists.

As to the origin of these bodies, the subject is involved in such obscurity that no satisfactory *conjecture*, not to say hypothesis or theory, has been as yet advanced. There is, however, some difference in the degrees of improbability, attached to them respectively. All that deserve any attention may be included under the following heads:

1. The meteoric stones are formed in the atmosphere.
2. They are thrown from the volcanoes of this earth.
3. They are ejected from those of the moon.
4. They are thrown from terrestrial comets.

The mere existence of so many hypotheses is sufficient to prove, that we have no real knowledge on the subject. A few remarks on each of these suppositions will suffice to show that it is much more easy to raise objections than to substitute a satisfactory explanation.

1. As to the atmospheric formation of these bodies. Of the ingredients found in these stones, sulphur is the only one ever known to be in the state of vapour, and the proportion of this found in the various meteoric stones that have been analysed, is extremely small. Silex and magnesia are not only not volatilizable, but they are nearly infusible; iron and nickel require the most violent degrees of heat to become fluid, and probably can never have more than a momentary existence in the state of vapour, even in the most powerful furnaces. How is it possible then that these substances should get into the atmosphere in the state of vapour or gas, and, if possible, why have they never been found in the air when it has been analysed?

Since the discovery of Mr. Davy that several of the earths have very combustible metallic bases, he has suggested that these bases may come into the atmosphere in a metallic state, and there take fire; but, if the decomposition of silex had been satisfactorily effected, which it has not, still this explanation would be embarrassed with difficulties which must attend the theory of the atmospheric formation of the meteoric stones, even allowing it possible for the materials of which they are composed to exist in the air, in the state of vapour or gas.

Should they combine in the air, is it credible that they would rush from great distances to one point, and there form a large solid body; would they not rather be precipitated in small masses or flakes like snow or hail? Hail is never precipitated in masses weighing hundreds of pounds; on the contrary, hail stones do not often exceed a few ounces in weight, and we have every reason to suppose that the region in which they are formed is often filled with aqueous vapour, where corpuscular attraction, could it ever exert such an extensive agency upon aeriform particles would produce a great aggregation of matter. These difficulties are much increased, when we consider that some of the meteors from which the stones have

descended, have been hundreds and sometimes thousands of feet in circumference; this is admitted by the best astronomers and philosophers, and is capable of being satisfactorily shown from deductions drawn from their apparent diameter, and the time that has elapsed between the extinction of the luminary at the explosion, and the arrival of the sound to the ear of the observer.

But, even waving all these difficulties, how could these meteoric bodies acquire their prodigious horizontal velocity? If formed in the air, they would descend rapidly in lines perpendicular to the horizon; but their motion is nearly horizontal, and it could not be communicated by the air; for, "the progress of the most violent wind is not more than two or three miles in a minute—but a meteor moves several hundred—the velocity of sound is less than 1200 feet in a second, that of a meteor more than 20,000 —the greatest force of gunpowder will throw a cannon ball but a very few miles, while a meteor is often seen to move several hundred." Other objections might be urged against this theory, but these are sufficient to prove that it is untenable.

2. Their origin from terrestrial volcanoes is still more improbable. The composition and appearance of the stones is different from that of any known volcanic substances; the stones have fallen hundreds and even thousands of miles from volcanoes; distances to which it is impossible that they should be conveyed, by any force that can be exerted at the surface of the earth, and when it is considered that the stones which have come down to us are merely minute portions, torn off from the great meteoric bodies, which have continued to move on after the rupture, and had they fallen, would have been of sufficient size in some instances, to have filled the craters of the largest volcanoes, this theory must be regarded as inadmissible, and, indeed, at the present time, I believe it has no advocates.

We are not assuming one theory to oppose another, for, luminous meteors, which have apparently exploded, and been extinguished, at the moment when atmospheric stones have fallen, have appeared in so large a proportion of the instances that are best attested, and most minutely described, that, notwithstanding some cases have occurred where the stones have apparently proceeded from burning clouds, and no fiery globe has been observed, still these appearances were probably the effect of optical illusion, or of the presence of the sun's light, and we are sufficiently authorised to conclude that atmospheric stones proceed from luminous meteors passing rapidly through the air, and no theory can be satisfactory which does not account for both.

3. Their ejection from lunar volcanoes, although supported by one of the most distinguished of the French philosophers, and countenanced probably by a majority of the men of science in Europe, appears to be hardly more tenable than the two preceding theories. It is admitted to be possible, that if a body were thrown from the moon with a force of about ten thousand feet in a second, it might pass the point of equal attraction, which is about twenty-four thousand miles from the moon's centre, and, then, if the earth and moon were relatively at rest, it would come in a right line to the earth's surface; but, as the moon and earth are both

moving forward in their respective orbits, the path described by a body projected from the moon would be a curve, the result of the composition of the motion of the moon in her orbit, the projectile force, and the power of gravitation, and the body would therefore probably revolve around the earth; if by any means pieces were detached from it, they would fall to the earth, and thus the theory appears to be possible, if we take into view only those insignificant portions of the meteoric bodies which come to the earth. Philosophers seem to have employed themselves principally in accounting for these, without taking into consideration that they are mere atoms of the bodies from which they have come. The body of a meteor is a firm compact substance, for no other could preserve the correct globular form in moving so rapidly through the atmosphere; and their light is usually well defined, so that hundreds and thousands of people who have seen them at once, give substantially the same account as to their apparent magnitude; hence there is good reason to conclude, that the estimates which have been made of their magnitudes have not been much overrated. Dr. Herschell estimates the altitude of the lunar mountains as being generally not more than half a mile; now is it credible, that bodies whose diameter is from two or three hundred feet to half a mile, should be projected from lunar volcanoes, and with such force as to go beyond the common centre of attraction, and arrive in the atmosphere of the earth? Indeed, if it may be permitted seriously to combat so extravagant a supposition, would not the re-action upon the moon itself produce a violent explosion of her own sphere, as a gun is burst by an over charge. We do not know the composition of the moon, and it may, for ought we know, be uniformly composed of silex, iron, magnesia, sulphur, and nickel, but this is in the highest degree improbable; yet as the meteoric stones are all of similar composition, the theory implies this, while we know that the lavas and other volcanic matters of our own earth are composed of the most various ingredients, and are often very dissimilar from each other.

Probably, not a year elapses without a meteor's being seen in some part of the world, and, had they been of lunar origin, no small part of that satellite would, ere this, have been shot off in meteors.

4. Their origin from terrestrial comets, is the only one of the theories which remains to be considered. That the earth may be attended by a system of inferior satellites corresponding to the solar comets, has been frequently suggested by philosophers; but we are indebted to the Rev. Thomas Clap, formerly president of Yale College, for an elaborate consideration, and a minute application of it to the explanation of the phenomena of meteors. This gentleman left behind him a paper containing "Conjectures on the nature and motion of Meteors." It was considered by its author as an unfinished treatise, but it was published some years after his decease, and although it does not appear that the learned author was acquainted with the falling of stones from the atmosphere, (for this subject had not then attracted the attention of philosophers,) this circumstance, instead of invalidating his theory, would have brought a great accession of strength to its support.

President Clap had it in view merely to account for the fire balls usually denominated meteors.

The explanation was founded upon an analogy drawn from the solar comets—particularly, from the eccentricity of their orbits, their consequent near approach to the sun in their perihelion, their prodigious distance at their aphelion, and the long course of time, in some instances hundreds of years, which they take to accomplish their revolutions. "President Clap supposed (see Professor Day's VIEW) that the earth is furnished with its system of comets, as well as the sun—that their size, and the period of their revolutions are proportioned to the comparative smallness of the primary body, about which they revolve—that, like the solar comets, they move off in very elliptical orbits; and, during the greatest part of their circuit, are too far distant to be visible—that, in their approach to the earth, they fall within our atmosphere—that, by the friction of the air, they are heated, and highly electrified—that the electricity is discharged with a very violent report—that they then move off in their orbits, and, by their great velocity, are soon carried out of our sight."

The appearance of the meteors is such as corresponds very well with this view of the subject.

The dimensions of these bodies, the rapidity of their motion, the direction of their course, the proportion which they bear in size to their central body the earth, being about the same as the little planets, recently discovered between the orbits of Mars and Jupiter, have to the sun, about which they revolve, all accord perfectly well with the supposition of planetary bodies moving through the lower part of their orbits, and not at all with what might be expected from matter falling from condensed gases or vapours, or projected from lunar or terrestrial volcanoes.

It is calculated, that if a body, moving horizontally near the earth, have a velocity of less than 300 miles in a minute, it must fall to the earth—if of more than 430, it will, if undisturbed by other bodies, fly of in an hyperbola, and will never return.

Adequate allowance being made for the resistance of the air, and the motion of the earth, a body will, within these limits, revolve around the earth in an ellipsis, and return at regular periods.

Now, it is very remarkable that the velocity of such meteors as have been observed is generally rather more than 300 miles in a minute, that is, just enough to carry them clear of the earth and yet so small as to bring them within its atmosphere, while moving through the lower parts of their orbits.

Granting the existence of these bodies, and, that their motion is such as has been described, it is easy to see that any cause which might produce a rupture or explosion of a part of their substance, might, very naturally, throw fragments to the ground, and the circumstances which have, in numerous instances, actually attended *their descent*;—its rapidity, proved by the holes which they make in the earth, the whizzing or roaring noise, and the violent concussion; its *irregularity*, the fragments being scattered over several miles of territory, which is what we might expect from the effects of a violent explosion; its happening immediately after explosions actually

heard from the fire ball and after the extinction of its light, and the minute proportion which the fragments bear to the whole body of the meteor;—all these circumstances considered together cannot leave a doubt that in numerous instances, at least, the stones have been thrown off from a large solid body moving rapidly through the atmosphere. But, the stones bear no sensible proportion to the whole meteoric mass, and this must be supposed to move on in its orbit, scarcely disturbed by the trifling loss which it has sustained, and no longer luminous, because the heat aud electricity have been, in a great measure, dissipated by the explosion.

There is nothing inconsistent with analogy in supposing the existence of numerous small planetary bodies in the solar system; they may be necessary to adjust the balances of motion and attraction, and they may well enough be of an uniform and sterile composition, since no analogy would lead us to suppose them inhabited, or even habitable. This conjecture derives confirmation from the discovery within a few years past, of several very small planets, in the solar system, where they had never been suspected before.

Upon this view of the subject, it is highly probable that meteoric stones have fallen, in every age of the world, and that this phenomenon will frequently occur again.

The theory of president Clap, with the addition which has now been stated, appears to be liable to only two objections, of much importance.

It may be said, that it does not account for such appearances as that of Sienna, and a few similar ones, where the stones have seemed to proceed from a burning cloud. Under such circumstances of terror and amazement, there is much room for optical deception, and perhaps we are not justified in concluding, that a meteor may not illuminate a cloud, by which it is in part concealed.

The other objection is founded on the apparent inadequacy of the cause assigned by president Clap, for the ignition of the meteors; it remains yet to be proved, that mere friction with the air is sufficient to produce strong ignition in a solid body, or to excite electricity enough to generate that effect, and the attendant explosion.

The explosion might however be owing, not merely to an electrical discharge, but also to the expansive force of vapour and gases, suddenly and powerfully rarefied by heat.

With these qualifications, the origin of meteoric stones seems to be better explained upon this, than upon any other scheme, but, as yet it can be regarded only in the light of an hypothesis, recommended by the felicity with which it explains most of the phenomena. Should one of the meteors ever approach the earth, without sufficient projectile force to carry it clear of our planet; its fall would be inevitable, and those philosophers who are so happy as to witness such a catastrophe, uninjured, will have better means than we now possess, for constructing a satisfactory theory on this obscure, but highly interesting subject.

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Note 37, *page* 110. *Gallic Acid.*

The due regulation of the heat is very important in this method of obtaining gallic acid. A moderate sand-heat is sufficient, and the retort must be removed from the fire at the moment when a dark coloured oil begins to rise, or before, because this oil will redissolve, or greatly contaminate the crystals of gallic acid.

Note 38, *page* 149. *Congelation of Alcohol.*

The congelation of alcohol was mentioned in a former note; it is to be regretted that we are not able to give the process by which this was effected; this, if published at all, it is believed has not yet reached this country. There are, however, a few facts relative to the appearances attending the congelation, which are worthy of notice. The alcohol was prepared according to Richter's process, and was of the specific gravity .798 at 62°; it was enclosed in a thermometer tube, in which it was congealed. This was afterwards effected in a tube sealed at one end and open at the other; the alcohol was so far congealed, that on inverting the tube, only a very minute stream of fluid glided down the inside of the tube, and, eventually, the solid alcohol fell out into a glass, was broken into several pieces, and quickly melted; in subsequent experiments the alcohol was so completely solidified, that no portion of it remained fluid. It was found that solid masses of alcohol could be soldered together;—in the paradoxical language of the discoverer, (Mr. Hutton of Edinburgh,) "a rod of frozen mercury or sometimes a straw cooled down to a very low temperature," was used as "a hot bath" for the purpose of fusing the frozen alcohol so as to admit of its being soldered. Mr. Hutton remarked that the alcohol crystallized, and that it sometimes separated into three very distinct strata; the uppermost was of a pale yellowish green, while the second was of a very pale yellow colour: both these strata were very thin, the last mentioned was rather the thickest; the lowermost stratum was nearly transparent, and colourless, and very greatly exceeded the other two in quantity." In order to ascertain whether these appearances arose from a decomposition of the alcohol, Mr. Hutton mingled the results of several processes, such as have been described, and heated them to about 120° by means of a water bath, by which means a perfect alcohol was reproduced. He therefore concluded that these appearances were owing to impurities, which accounted also for a difference in the forms of the crystals which had been obscured in different experiments. Mr. Hutton concludes that

the lowermost stratum contains the true alcohol, and that the other two contain, chiefly, volatile impurities, which can be separated only by freezing, and that it is to these that the alcohol owes its peculiar flavour.

Note 39, *page* 220. *On the Artificial Preparation of Mineral Waters.*

It is only within the last half century, that a correct knowledge of the nature of mineral waters has been obtained. Their utility in a variety of diseases has been proved by the uniform experience of mankind from remote ages; even savage nations know that there is a very great diversity in the qualities and effects of different natural waters, and they are accustomed to make use of them for not a few of the same purposes that we do. The most powerful and celebrated mineral spring of this country, was known to the Indians in its vicinity, and they first pointed it out to the white people. Before the composition of mineral waters was understood, their efficacy was imputed in a great degree, to a supposed fermentation in the bowels of the earth and to some volatile principles, too subtile to be detected by the art of man. The notions concerning them were visionary and fanciful, and bordered, not a little, on superstition.

It is not the least, among the attainments of modern chemistry, that more correct views of this subject have been acquired, and that the exact analysis of all the most celebrated natural mineral waters has led the way to their artificial formation, upon principles of science and common sense.

To the illustrious Bergman we are indebted for some of the earliest practical researches, and most useful directions on this subject. He analysed, with accuracy, several of the famous waters of Germany, and having discovered their contents, he applied himself with such ardour and success to effect their recomposition, that in a short time, the prepared waters were introduced into the remotest provinces of Sweden. The dissertations of Bergman on these subjects should be carefully perused by all who are engaged in these pursuits.

Strictly speaking, all waters except rain and snow, and distilled waters are mineral; because they all contain, in a greater or less degree, mineral substances dissolved in them; even rain and snow water are not perfectly pure, and it may be doubted whether water ever is, unless distilled in glass vessels, for, water which has been condensed by the pewter worm of a common still gives a precipitate with sulphuretted hydrogen. In most natural springs and rivers, however, the proportion of foreign matter is so minute, as not materially to affect their sensible or chemical properties, and, it is only when this is the case that the term *mineral* is, with propriety, applied to a water.

Although there is a very great variety in the degree and nature of the impregnation of different waters, they are commonly included under a few general divisions, according to the kind and proportion of the ingredients which they contain.

They are either, 1. Saline; 2. Chalybeate 3. Acidulous; or, 4. Hepatic; the first, distinguished by the prevalence of saline ingredients, the second by iron, the third by carbonic acid, and the fourth by sulphuretted hydrogen. This division is rather loose, as these classes are often

more or less mixed with one another, and there are a few substances of more rare occurrence, that are not included under either of them. It may serve, however, as a guide in designating the principal varieties of operation that are necessary in forming the different sorts of mineral waters. It is almost superfluous to remark that a correct knowledge of the constitution of a mineral water must be attained before we can hope to succeed in preparing it artificially, and, the chemist must either perform the analysis for himself, or confide in that of some other person.

I. Of Saline Waters. The artificial preparation of this class of waters is the most simple and easy, although their analysis is often the most complicated and difficult. All that is necessary is merely to weigh out the different salts, in the proper proportions, and dissolve them in the water.

Some of these salts are sold regularly in the shops of the apothecaries. Such are the sulphate of soda, (Glauber's salt) the sulphate of magnesia, (Epsom salt) the carbonate of soda, (sal soda) &c. The muriate of soda, (common salt) is in every family. Sometimes these salts are sufficiently pure to be employed without any farther trouble, but, more generally, it will be necessary to redissolve and crystallize them anew.

There are some salts which are denominated *incompatible*, because they cannot exist in the same solution without mutual decomposition; such are muriate of magnesia and carbonate of soda; were a solution of each of these salts to be mingled, there would be an immediate precipitation of carbonate of magnesia; and muriate of soda, alone, would remain in solution. Should any analyst imagine that he had discovered such salts in contemporaneous existence in a mineral water, he must of course conclude that his analysis is erroneous, and therefore, in any attempt to form an artificial water, he will be careful not to mingle any such inconsistent ingredients.

Some salts are not to be found in the shops, and therefore must be prepared on purpose. Such are muriate of lime and muriate of magnesia.—It is best to prepare these salts by adding the carbonates of lime and magnesia to muriatic acid diluted with one or two parts of water. For the former, marble powder should be used, formed by pounding in a clean mortar very white marble, and, if the powder have been previously exposed to a full red heat, till as much carbonic acid has been expelled as can be driven off in that way, it will dissolve with much more facility. Chalk may be used, but this is apt to produce a very frothy and troublesome effervescence, unless the acid is largely diluted, when the action will be slow; the same remarks are applicable to the carbonate of magnesia.—As the muriates of these two bases are very deliquescent and difficult to be crystallized, and, as they are prone, when very much concentrated, to become gelatinous, it is convenient to keep them in the fluid form, in close stopped bottles. A small portion may be measured out; for instance, two gills, and evaporated to dryness, and the residuum weighed; this will inform us how much solid salt is contained in any measured portion of the solution, and thus, much trouble may be saved, as the salts may be introduced into the water in the fluid form. There are a few salts occasionally found in mineral waters, which it may be advisable not to intro-

duce. Such is the sulphate of lime ; it does not possess any known medical efficacy, and it may be deposited in the system and create serious obstructions. For similar reasons, it is even doubtful whether the carbonate of lime ought to be added to artificial waters, at least in the proportion in which it is often found in native mineral waters ; for, as it is dissolved in them only by the aid of the carbonic acid *in excess*, it follows that, when this acid, by the warmth of the system, is expelled from the water, in the course of its circulation, the carbonate of lime may be deposited in some of the cavities and prove a troublesome impediment ; especially in the kidneys, the gall bladder or urinary bladder, and the ducts connected with them. The carbonate of magnesia is liable to be affected in a similar way, and, although these carbonates are, both, good correctors of acidity, and, in that way, useful in mineral waters, they may not always meet with an acid in the passages, which they may neutralize, and by which they may be carried off; if they should not meet an acid in the system, they would probably be deposited. Besides, their place, as antacids, is much more than supplied by carbonate of soda which is liable to none of these objections. In the composition of some mineral waters, it may therefore be adviseable to omit some of the ingredients and even to substitute others ; for, we are not to presume that the substances which a mineral water has chanced to dissolve in its progress among the strata, are necessarily such, either in kind or proportion, as are best adapted to cure diseases, and therefore, it is clearly possible that a water of great utility may be formed without imitating any native mineral water. Such experiments however, ought to be directed by medical as well as chemical science.

Among the salts which have been discovered in mineral waters, the carbonates of lime, magnesia and iron ;—the sulphates of soda, magnesia and lime ; the muriates of soda, lime and magnesia, and the hydro-sulphuret of lime are the most common, and they are those with which we have most to do in the preparation of artificial mineral waters. Iron is almost the only metal of much importance found in waters ; copper occurs, but more rarely, and it is not often that waters impregnated with it are used medicinally, as it is so poisonous to all animals.

II. Chalybeate Waters. Iron gives the character to this species of waters, and it is almost always suspended in them by the carbonic acid ; it, sometimes, occurs combined with the sulphuric acid, but this fact is so rare that chalybeate waters are generally acidulous and sparkling, and sometimes they are very highly charged with the carbonic acid. The method of making a water chalybeate is simply this : very pure and clean iron, in the state of filings, is to be introduced, in the proper proportion, into water charged, or immediately to be charged, with carbonic acid ; the iron will be oxidized, in the lower degree, by the water, and then will be dissolved by the carbonic acid, and the more highly the water is charged with this acid gas the more rapidly and in the greater proportion will it dissolve the iron. In estimating the proportion of the iron to be added to the water, we must allow only so much as, when combined with the oxygen and carbonic acid will equal the weight of carbonate of iron found, by analysis, in the water which we would imitate. A small quantity of iron imparts to water such decided

properties that it is necessary to be very attentive to the proportion of iron. If the iron be in the higher state of oxygenizement, *it will not dissolve in the water* impregnated with carbonic acid, and if, after solution by this acid, it be exposed to the atmosphere, the carbonic acid will principally escape; the iron will pass to the state of red oxide, and will be precipitated, a mere rust, and the chalybeate will thus be decomposed. It is therefore, for both these reasons, indispensable, that artificial chalybeate waters be prepared and kept in air-tight vessels. It is for the same reason that Bergman recommends introducing the iron filings in a small bag, and directs that when the bag is removed from the mineral water vessel, it should be immediately plunged into clean water, by which means it will be kept from passing to the state of red oxide; for, the rusting of iron in common cases, is effected by the joint action of water and the atmospherical oxygen. The method recommended by Bergman of introducing an indefinite quantity of iron filings in a bag, I have found by experience not to be so good, as to put in the exact quantity of iron that is wanted, for more gives the water too high a chalybeate impregnation, and it is apt to become turbid, and to have a very disagreeable odour, like hydrogen, and, indeed, this smell probably proceeds from hydrogen, condensed in the water during its decomposition by the iron, for the chalybeate waters are prone to have something of this odour. In some artificial chalybeate waters *sulphate of iron* is introduced instead of combining the iron in the manner that I have described. This is a great error, and, no person will ever, in that way, succeed in imitating the native carbonated chalybeate waters. The taste and other sensible properties, as well as the medical effects are very different. Whether an artificial chalybeate has been impregnated with the sulphate or carbonate of iron, may be easily decided by the same process which is applied to natural waters of these descriptions: viz. heat the water for a short time; if it is a carbonate, the iron will speedily be deposited, in the form of a rust, and the water will no longer give the well known precipitates with the prussiate of potash and with gallic acid. But, if a sulphate of iron be present, there will be little or no deposite during the heating, and the fluid will answer to the above mentioned tests as well as before. When water is highly impregnated with carbonic acid, it acquires the chalybeate taste and other properties very rapidly; the iron can be tasted within half an hour, after it is introduced, and twelve hours will produce a decided impregnation. Chalybeate waters are often more or less saline; indeed they are usually so, and some of them are strongly impregnated with salts. There is no incompatibility between the carbonate of iron and the salts most commonly found in chalybeate springs; it frequently exists in company with the earthy carbonates and sometimes even with the carbonate of soda. In forming a saline chalybeate, nothing more is necessary than to mix the salts, in the proper proportions, with the water, then to add the iron, and then inject the carbonic acid without delay, and to the intended extent.

III. Acidulous Waters. This is a highly interesting class of mineral waters, whose nature was entirely unknown till the discovery of carbonic acid assimilated them with the brisk fermented liquors, such as Champaigne wine, porter, cider, perry, &c. which owe their grateful pungency and

briskness to the same cause. There is a very great difference in the proportion of carbonic acid existing in different mineral waters; even common water contains a small portion, and there are mineral springs which are impregnated with two or even three times their bulk of this acid gas. It is the introduction of this gas which forms the most difficult and laborious part of the business of preparing artificial mineral waters. It is in this department, particularly, that modern improvements have attained a degree of excellence surpassing all previous conception, and producing results which have demonstrated that art can sometimes transcend the productions of nature.

Those who have not the means of doing better, may still practise the ingenious, altbough simple, processes of Bergman. The water to be impregnated with the carbonic acid may be introduced into a bottle, which should be quite full, and inverted in a proper vessel; carbonic acid, from a mixture of marble powder and dilute sulphuric acid, may then be passed up into the bottle, till about one third of the water is displaced; then, one hand being slid under the bottle's mouth, and the other placed upon its bottom, the bottle must be briskly agitated; an absorption will take place, the hand will be pressed fast to the bottle's mouth, it should be withdrawn under water, a portion of which will rush in to supply the void, and a repetition of this operation, will soon saturate the water as far as it can be at the given temperature, and under the given pressure of the atmosphere. The water, thus impregnated, will have a mildly pungent and acidulous taste, and will sparkle when poured into a tumbler. The colder the water is, the more gas will be absorbed. If it is wished to add any saline ingredients; that can be done either before or after the impregnation with carbonic acid; and iron may be added to make it a chalybeate; for the acidulous waters are usually both chalybeate and saline. Although, by the means which have just been described, water can be impregnated as highly as it commonly is, in the natural acidulous waters, the impregnation may be carried much farther by peculiar contrivances and maniplations. I do not allude to the apparatus of Nooth or Priestly, which, although elegant and showy, and sufficiently powerful for the experimental illustrations of a lecture, is altogether improper for operations on a large scale and where it is desired to apply a great degree of force to effect the combination. The principal means by which water is charged with the amazing quantities of carbonic acid gas which are, now, introduced into it, may be reduced to three heads.

1. Pressure. 2. Cold. 3. Agitation.—All these are combined in the most perfect manufactories of mineral waters, and some observations will be necessary on each of these heads.

1. Pressure. This is applied by means of strong forcing pumps which may be worked either by hand alone, by the hands aided by a lever, by a wheel, by coggs and cranks, or any other convenient mechanical power, and if the strength of men be not sufficient, that of horses may be applied, and even water, wind, and steam may be called in to our aid. This is however, by no means necessary. A strong man, after becoming accustomed to the exertion, will inject as much gas as will impart to the waters a degree

of activity far surpassing any thing which they ever possess in nature. As this impregnation depends entirely on the pressure which is applied to the gas to force it into union with the water, it is obvious that the containing vessels must possess a degree of strength proportioned to the force which is to be applied. Glass is entirely improper, however thick, and apparently strong, because an explosion, which is no uncommon accident in these operations, would be attended with the most hazardous consequences. The vessels must therefore be made of wood or metal. Very strong casks of oak, made of the very best timber, and constructed in the most careful manner, are the most proper instruments, if we regard, primarily, the purity of the waters and the health of those who use them. The casks must be very strongly bound and guarded with iron hoops and strong iron bars in every direction; they must be furnished with an internal apparatus for agitation, or they must rotate on an axis to effect the same object. Their strength must be such that they will not strain so as to produce cracks, or even the smallest aperture, for absolute tightness is indispensable to success. In an apparatus of this kind, water may be combined with four or five times its bulk of carbonic acid gas, and it then dissolves iron with considerable rapidity, and the carbonates of lime and magnesia are also taken up by the excess of carbonic acid.

The containing vessel may be made of copper, tinned on the inside, and secured by being enclosed in a strong iron bound cask. This structure has the advantage of greater strength and tightness, and of being repaired with less difficulty than vessels made of wood. The only objection against it arises from the great tendency which copper has to become corroded by most chemical agents; the tin is a partial protection, but there is reason to fear that in the course of some time, the tin will become so thin as not to protect the copper, and thus a deleterious impregnation may get into the water.

2. Cold. With a given pressure more gas will be combined with water the colder it is kept during the operation. Therefore, the containing vessels should, if possible, be surrounded with ice during the impregnation, or immersed in cold water. If the vessels have been suffered to lie in an ice house and thus to become ice cold, it will greatly facilitate the combination.

3. Agitation. Most of the remarks under this head have been already anticipated. Agitation is necessary in order to bring the water and gas into complete mixture, and to mingle water that is more highly saturated with that which is less so, that thus there may be an equal distribution of principles, which, without agitation, it would take much longer to effect. At the end of the operation the water in the containing vessel exists under a prodigious pressure. In order to create fountains of mineral waters, nothing more is necessary than to connect a proper tube with the containing vessel, and let it pass into an upper room and terminate in any convenient or ornamental jet, furnished with a stop-cock. This apparatus should be made of materials that will not contaminate the water. On opening the stop-cocks, the water will, of course, be discharged with a velocity proportioned directly to the pressure in the containing vessel, and inversely to the distance which the water has to ascend. By means of a peculiar contrivance

the impregnated water can be transferred from the containing vessel into bottles, still retaining nearly all the pressure which it had in the vessel; consequently, when the bottles are opened, the fluid will fly or sparkle as the fermented liquors do. Glass bottles are not strong enough for this purpose, and the stone ware bottles of this country are not sufficiently firm in their texture to contain the impregnated water; the pressure forces it through the sides of the bottle upon which it appears like a dew. The bottles made for this purpose in London are entirely impervious.

IV. Hepatic Waters.

Waters of this description are so extremely offensive, on account of the fetid odour which attends them, that they are rarely demanded as an article of manufacture. On account of the action which they exert on most metallic substances it is proper that only clean glass vessels should be used in manufacturing them; a tub of wood *not painted*, may be used as a pneumatic cistern. In impregnating water with sulphuretted hydrogen it is not necessary to employ the powerful condensing machines which have been mentioned. Were there no objection to the use of metallic instruments, still it would be unnecessary to condense into water a very large quantity of a kind of gas, of which the smallest portions can hardly be borne. Water impregnated with sulphuretted hydrogen as highly as soda water is with carbonic acid, would, when drawn, either from fountains or bottles, emit a most noxious and insupportable effluvium. To form an hepatic water, either a portion of the dry sulphurets of lime, soda, or potash, may be dissolved in water, when it will immediately acquire the hepatic odour; or (a way that is probably better) sulphuretted hydrogen gas, derived from sulphuret of iron, and diluted sulphuric or muriatic acid may be passed into an inverted bottle containing water, in the manner that was mentioned for forming the acidulous waters. Agitation being used, a sulphureous water will be obtained, sufficiently strong for medical purposes. A sulphureous bath may be formed by passing a stream of sulphuretted hydrogen gas through a tub of water, taking care to agitate the water frequently. The gas that does not combine in its passage may be caught in an inverted jar, and poured from it into another, and back again, till the water is sufficiently impregnated. The hepatic waters frequently contain some of the ingredients of the preceding classes, and these may be added by very obvious means.

In manufacturing mineral waters of every description, and especially those of the three first classes, care should be taken to select a natural water, which is, in a common sense, pure, that is, free from any peculiarity of odour, taste, or colour.

Note 40, *page* 272. *Test for Arsenic.*

Dr. Marcet, one of the physicians to Guy's hospital, London, has invented a new test for arsenic. His directions are as follows: "To the suspected fluid, previously filtered, add, first, a little dilute nitric acid, and, afterwards, nitrate of silver, till it shall cease to produce any precipitate. The muriatic acid (if any be present) being thus removed, whilst the arsenous acid (if any and in whatever state) remains in the fluid, the addition of

ammonia will instantly produce the yellow precipitate in its characteristic form. It is hardly necessary to add, that the quantity of ammonia must be sufficient to saturate any excess of nitric acid which the solution may contain. (Phil. Mag. Vol. XLI. page 124.)

The yellow precipitate here mentioned, is a compound of white oxide of arsenic, or arsenous acid with oxide of silver; the use of the ammonia is to form an arsenite of ammonia, which, by double decomposition with nitrate of silver, affords arsenite of silver, and nitrate of ammonia, which last remains in solution, while the arsenite of silver is precipitated. The nitric acid is added, to prevent the arsenite of silver, which is soluble in nitric acid, from being precipitated in mixture with muriate of silver, when muriatic acid is present; if this latter acid is not present, there is no occasion to add nitric acid. "The addition of ammonia is necessary because arsenic acid alone cannot decompose nitrate of silver; but in Fowler's solution, in which the arsenic is already combined with an alkali, the decomposition takes place at once without any addition of ammonia. The fixed alkalis can therefore answer a similar purpose; but ammonia has this sdvantage, that it does not, when added singly, decompose nitrate of silver, a circumstance, which, in using the fixed alkalis, might occasion some confusion." "The quantity of ammonia must not be too large, for in that case the precipitate is re-dissolved. But, even then, it may be made to re-appear by the addition of nitric acid in sufficient quantity to saturate the alkali. In this case however the precipitate is not permanent, owing to its being soluble in the nitrate of ammonia, which is formed in the process. Carbonate of ammonia has also the power of producing and re-dissolving the precipitate.

"The fixed alkalis in excess, have not the power of re-dissolving the precipitate."

APPENDIX TO THE NOTES.

Iode or Violaceous Gas.

I subjoin an account of this new substance from professor Cooper's Emporium, No. 5, page 175, having seen nothing more extensive on the subject.

Iode or Violaceous Gas. The Royal Society met, after the holidays, when a paper from Sir H. Davy was read, describing a new and important discovery. About two years ago, a Parisian manufacturer of salt petre, using all kinds of sea weed as a substitute for barilla, discovered that his vessels were excessively corroded by a particular substance of a beautiful violet colour; he communicated the fact to some Paris chemists, but no particular notice was taken of it, until Sir H. Davy went to Paris.

This new substance is easily procured, by pouring sulphuric acid on the residuum of sea weed, after the carbonate of soda has been extracted. It appears that all the vegetable products of the sea shore yield it when thus treated. By pouring the acid on the residuary ashes of the sea weed, this new and most beautiful violet coloured gas is obtained.

The French propose calling it iode gas (from the Greek word *ion, violet*) but Sir H. Davy prefers the term *violaceous* gas, as most suitable to English phraseology; its combination with hydrogen he agrees may be called *hydro-iodic-gas*, &c. Its properties are equally important to the scientific chemist and manufacturer, as a dye and pigment. It is the heaviest known gas; 100 cubic inches of it weigh 95—5 grains; it is easily disengaged at the temperature of 156°; at a low one, it condenses into fine violet coloured crystals; it is rapidly absorbed by the metals, uniting with iron, mercu-

ry, tin, lead and zinc, and changing them into salts of the most beautiful tints of yellow, orange, and brown. It has many analogies with oxygen, the alkalis, and chlorine or oxymuriatic acid. Like the alkalis, it has great affinity to oxygen, from which it can be expelled by heat; it experiences no change by the action of the voltaic pile, yet rapidly combines with phosphorus, hydrogen, and all the muriates; it is a non-conductor, is very slightly combustible, yet it is a supporter of combustion. It is so easily united with all the common metals, and converts them into such fine pigments, that, before as many months elapse in this country (England) after its discovery, as years have done in Paris, it will be prepared by all our colour manufacturers, and used by our cabinet makers, wood stainers, and dyers. The existence of this substance tends to support an opinion of Sir H. Davy, that acids and alkalis do not depend on any peculiar acidifying principle, but on certain modifications of matter. All the iodats of iron and zinc are soluble in ether and spirits of wine, and many of them in water.

New Explosive Compound.

It is some time since we were informed in this country, that a new explosive compound had been discovered at Cambridge in England, by Mr. Burton; that it was formed by the action of nitrate of ammonia in solution, upon oxy-muriatic acid gas, and that it was supposed to be a compound of nitrogen and oxymuriatic acid; its explosive powers were said to be of the most terrible kind, and the chemical world heard, with much concern, that Sir Humphrey Davy had sustained a severe injury from it, which had endangered his sight. More recently, a very able and interesting report concerning this new substance has appeared in Nicholson's Journal, (Vol. xxxiv. page 180 and 276) and we are indebted to its authors, Messrs. R. Porrett, Jr. W. Wilson, and Rupert Shirk, for much curious information, some of the most important particulars of which will be mentioned in the following note.

The compound was formed by these gentlemen by filling, over warm water, glass receivers of the capacity of about sixteen cubic inches, and transferring them into small basins containing the ammoniacal saline solutions. The compound can be formed, not only from the nitrate of ammonia, but from the phosphate, muriate, sulphate and oxalate, and from the muriate of zinc with excess of ammonia, and from the muriate of ammonia and iron by sublimation. The carbonate of ammonia, triple muriate of platina and ammonia, and the sulphate of copper with excess of ammonia did not afford it. Its formation was prevented by sulphur in solution in the ammonia, or in powder within the receiver; by charcoal in fine powder, adhering to the interior moist surface of the receiver, by carbonic acid gas, or atmospherical air equal in volume to one third the chlorine gas, or by an equal volume of hydrogen gas.

It has been asserted that the compound was best formed at a temperature below freezing, but this proves to be erroneous; on the contrary, it succeeds best, if the solutions be warm; when at 90°, it was abundantly and quickly formed, and more rapidly still, when the solution was at 180°.

"As soon as the receiver of chlorine gas is placed in the solution of the ammoniacal salt, an absorption of the gas commences, and the solution rises slowly in the receiver. An action is apparent on the surface of the solution, which resembles small filaments reaching to the depth of about one tenth of an inch. These filaments, on close inspection, appear to be composed of extremely minute bubbles of gas, ranged in a line one above another to the surface. When about one fourth of the gas has disappeared, some of the explosive compound may generally be observed on the surface of the solution in a thin film; the surface then looks oily, and appears divided so as to give the idea of a map. As the solution rises in the receiver, the quantity of the explosive compound increases; and it then collects into one or two flattened globules, which, when they become very bulky, fall through the solution to the bottom. The whole of the gas is absorbed. The solution, after the formation of the compound, contains free muriatic acid, and also

some of the compound in solution, if we may judge from its smell and yellow colour." The authors of the memoir before us reason upon the hypothesis of Sir Humphrey Davy respecting chlorine, and say, that the chlorine gas is in part absorbed by the solution, "and there decomposes the ammonia of the salt, by combining with its hydrogen (with which it forms muriatic acid) and sets free its azote, to combine with another part of the chlorine, with which it forms the explosive compound." Upon the old hypothesis we should say, that the oxygen of part of the oxymuriatic acid combines with the hydrogen of the ammonia to form water; muriatic acid is thus set at liberty, while the remaining oxymuriatic acid combines with the nitrogen, to form the explosive compound. The two theories, therefore, agree in the material fact, that the compound is essentially formed between the oxymuriatic acid and the azote.

The same explanation applies to other ammoniacal salts; "the nature of the incombustible acid (with the exception of the carbonic) being of no importance, the only use of the acid being to prevent, by engaging the ammonia, the rapid action which the chlorine gas would exert on that alkali in an uncombined state; the existence of it in that state would also be incompatible with that of the explosive compound." This is true, notwithstanding that the explosive compound can be formed by confining chlorine gas over a solution of pure ammonia; but, in this case, the explosive compound is really formed from the muriate of ammonia, which is produced between the oxymuriatic acid and the ammonia.

The result of the action of oxymuriatic acid and ammonia is different according to the proportions; if "the quantity of ammonia present in a free state, is more than the chlorine can decompose and neutralize, the whole of the chlorine gas goes to the formation of muriate of ammonia, and no explosive compound is formed, but in its stead, azotic gas is found at the termination of the experiment, equal in volume to one third of that of the chlorine gas employed"—"but when the quantity of chlorine gas present, is more than is necessary to bring the ammonia to a neutral state; or, which is still better, when the ammonia has been previously neutralized by an acid, the azote, instead of remaining after the experiment in a state of gas, is found combined with the superabundant chlorine forming the explosive compound."

Some of the most important properties of the explosive compound are as follows: "Its colour is that of bees wax; it is very fluid; it sinks, although with extreme slowness, in a solution of red sulphate of iron. Hence we conclude, that it must be of the specific gravity of about 1.6. It disappears after some time, even under the surface of water, or of the solution in which it was formed; but evaporates almost instantaneously when exposed to the air; it then diffuses its peculiar and penetrating odour through the surrounding atmosphere, which then affects the eyes in a very painful manner, causing them to shed tears. Its action on the lungs, however, we conceive to be much milder and less prejudicial than that of chlorine gas."

The compound is difficult to keep, on account of its volatility; if put however into a glass tube about nine inches long, of which it should fill about half an inch from the bottom, the remaining space being nearly filled with the solution; and if the tube be then hermetically sealed by the blow pipe, it may be preserved for a length of time, but is finally dissolved in the water of the solution unless the quantity of water is small. Its volatility renders it equally difficult to transfer the compound from vessel to vessel; this is best done by drawing it up into a small glass syringe, the piston of which may be made of wood or copper, and wrapped round with cotton; it is easily ejected from the same instrument. It is very necessary, that every instrument employed about it should be perfectly clean, as the smallest quantity of grease, oil, or other combustible matter will cause it to explode; and, although it ordinarily does not explode without such contact, or without a temperature of 200°, yet in a course of 200 experiments three explosions took place, whose cause was completely unknown; therefore a mask and gloves should be worn during all experiments on this substance.

This compound remained fluid at —16°; at 160° it distilled rapidly, and much gas was evolved; it did not explode at 200°, but was nearly evaporized; at 212° it exploded violently. Its exploding temperature is therefore above 200° and not above 212°.

The compound was easily converted into vapour when the pressure of the atmosphere was removed or materially diminished; by the application of red hot iron to the tube containing the vapour, it exploded, and shattered the tube.

The explosive compound was not altered by the current of galvanic electricity.

A globule of the compound was placed beneath water, in an iron ladle, or sometimes in a paper filter, and thus a great variety of substances were brought into contact with it.

Explosions more or less violent occurred with the following substances;—

Super-sulphuretted hydrogen formed by adding hydroguretted sulphuret of potash to muriatic acid.

Phosphuret of lime, phosphorus, (extremely violent,) caoutchouc, myrrh, phosphorus dissolved in liquid, sulphuretted hydrogen, phosphuretted camphor, palm oil, ambergris, whale oil, olive oil, do. camphoretted, do. sulphuretted, do. thickened by boiling on oxide of mercury, linseed oil, oil of turpentine, oil of tar, do. of amber, do. of petroleum, do. of orange peel, various metallic soaps as of silver, copper and lead, and manganese, pure fused potash (owing to the heat produced by combining with the water,) solution of pure ammonia, phosphuretted hydrogen gas, sulphuretted do. arsenic melted do. oxygen gas, nitrous gas. (A peculiar apparatus was used to bring it into contact with gases.)

Combustible bodies act on this compound with the most energy; there are however some exceptions, as in the case of ether and alcohol.

The effects appear to be owing principally to chlorine in a very condensed state, and in weak chemical union; they resemble those produced by the gas separated from oxymuriate of potash by strong sulphuric acid.

There are some combustible bodies, which unite with this compound without decomposition, of which camphor is a remarkable instance.

Animal substances appear to act with less energy than the analogous vegetable ones, of which adipocire, spermaceti, butter and lard are examples.

Earthy salts do not explode with it; among the metallic ones those formed from the nitric salts do, and those from the muriatic salts do not explode.

Our limits will not permit us to introduce the statements and reasonings of the ingenious authors of the memoir now under consideration; their general conclusions are, that the compound consists of a large quantity of chlorine gas very much condensed, and in union with a small quantity of nitrogen; they think they find reason to conclude also that hydrogen enters into the composition of the compound, and they admit that it is possible oxygen also does.

The subject is very curious, and serves to admonish us that we may be, and probably are, very far from having discovered all the active and even dangerous compounds, of which, under various modifications, matter is susceptible.

GENERAL INDEX.

[The following Index refers only to the original work, and not to the Notes of Professor *Silliman*, which are noticed only in the Table of Contents at the beginning of each vol.]

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